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EDITORIAL

STATISTICS IN RURAL ECONOMY

STATISTICS were originally considered to be figures relating to the resources of the State with regard to its man power, and were at first almost solely concerned with the numbering of human heads. However useful such figures may be in levying a poll-tax they by themselves are of little more value. As statesmanship developed the application of information to demonstrate the condition of the people became more and more of use until in recent times figures relating to all factors bearing upon the human population of a country have generally become recognised as a fundamental necessity in forming plans for social progress. Statistics and statistical method have become a science. A modern application of statistical method is the collection of figures of individual behaviour and the formulating and applying them to guide us in the planning of crop and animal experiments.

There is an important point that requires careful realisation and that is the clear distinction between the mere mathematics of the statistician and the deduction to be drawn from the figures, by the application of clear reasoning to them, of lines along which progress can be attained. There is a danger in statistical method becoming too mechanical when applied to living things

The prevailing conditions in Ceylon at the moment as the result of pestilence and drought have brought home to us how lacking we are in statistical information that could supply us at once with much that we want to know concerning the life of the countryside. From an agricultural point of view the first but by no means the last set of figures we require is that relating to the production of our village crops apart from tea, rubber, and coconuts. We have in fact no system of crop reporting. It affords interesting reflexion to read a recent publication issued by the National Agricultural Research Bureau, Ministry of Industries, Nanking, China. A map of China is therein given showing the location of 4,095 Crop Reporters who forward figures to the Directorate of Statistics for the purpose of answering two questions.

1. What production of crops are we likely to have, or do we have, already in a given year as compared with other years?
2. What changes have taken place in the country that will affect the nation's rural economic situation for the present and for the future.

There is indication of a beginning in China along lines that might be of value in Ceylon.

TICK-BORNE DISEASES OF CATTLE IN CEYLON

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THERE is an important group of diseases in cattle occurring in many parts of the world in which transmission is by ticks much in the same way as Malaria in man is transmitted by mosquitoes.

Of this group at least three occur in Ceylon and as they are of considerable economic importance it is advisable that cattle owners should be familiar with them.

The three representatives of the group which are known to occur in Ceylon are all caused by protozoal organisms which are found in the blood stream parasitising the red blood corpuscles, in this respect they can be considered as analagous with the malarial parasites of man.

The diseases caused by these three parasites are characterised by fever, anaemia and loss of condition, but they have each certain individual features which will be mentioned later.

All three diseases have the following features in common. Cattle of the Native and Indian breeds have a very marked resistance and it is seldom that serious symptoms are observed in such cattle; calves and young cattle are much less severely affected than adults; recovery from infection confers a resistance to reinfection.

Cattle of European or Australian breeds are much more susceptible than Native or Indian cattle and suffer seriously when affected.

The three diseases are extremely common in most parts of Ceylon, indeed it would probably be safe to assume that all cattle which are allowed to roam at large are infected. That is not to say that they will be showing symptoms of illness but they are harbouring the parasites in their blood and are capable of infecting ticks which may suck blood from them and so through the ticks can infect other cattle.

That this is so can readily be proved by taking a small quantity of blood from an animal, to all appearances healthy, which has been living in an area where it is exposed to ticks and injecting it into a susceptible animal which will develop the disease after the usual period of incubation.

In an area where these diseases are enzootic, and this applies to the greater part of Ceylon certainly to practically the whole of the low-country, symptoms of illness sufficiently severe to attract the attention of the owner are seldom or never seen in the locally bred cattle. If however cattle from an area where these diseases do *not* occur are introduced into an enzootic area and exposed to the bites of infected ticks very severe symptoms are soon produced.

A cattle owner in an area where these diseases are enzootic who maintains his herd by rearing his own calves and never introduces into his herd cattle from an area free from these diseases may be unaware of the existence of these parasites in his cattle.

It will thus be seen that so long as a cattle breeder in an enzootic area, as for example in the low-country, is content to breed his own stock especially if he keeps only cattle of the Native or Indian breeds, these diseases are of comparatively little importance.

On the other hand when he wishes to introduce outside cattle especially cattle of European or Australian breeds they at once become of very great importance. These diseases are the chief obstacle to the use of cattle of European or Australian breeds for the purpose of improving the breed of cattle in the low-country. The failure which so commonly follows the introduction of such cattle into the low-country and which owners usually attribute to the climate, the heat, or lack of suitable grass is in most cases due to tick-borne disease.

In Ceylon these facts are brought most strikingly to notice in connection with the trade in milch cows brought from up-country to the dairies in and around Colombo. These cows are nearly all of European or Australian breed and are bred on tea estates at high elevations. On many of the tea estates there is no place where the cattle can be grazed so they are kept in the cattle sheds from the day they are born and hand fed. As a result many of these cattle grow up to maturity without having

ever contracted any of the tick-borne diseases, in consequence many of them are highly susceptible when they are taken to Colombo as adult cows in milk.

On their journey to Colombo they may pick up infected ticks from the grass on the roadsides on their way to the railway station or it is possible that they may pick up ticks in the cattle trucks. On arrival in Colombo they may be taken to a dairy actually in the town where they will be kept in the cattle shed and not allowed outside. In such dairies, if they have escaped infection on the journey, up-country cattle of European or Australian breeds may do very well.

On the other hand they may be taken to a dairy on the outskirts of Colombo. Such dairies are usually on coconut estates or small coconut properties. In such dairies it is the usual practice to tie the cattle outside under the coconut palms for the greater part of the day. Here they are exposed to the attacks of ticks which have fed on infected cattle and soon contract infection.

The subsequent course of events will depend on several factors namely the degree of resistance which the cattle may or may not possess, the species of parasite with which they became infected, the extent of infection and the method of treatment adopted. Here before going further it will be advisable to mention the three common parasites found in Ceylon with a short description of their characteristics and the types of disease they may produce.

First and perhaps the most important is *Piroplasma bigeminum* a large pear-shaped organism found in the red corpuscles of the blood. It causes a disease which is often referred to as "Red-water" on account of the red colour of the urine which occurs in many cases. The period of incubation, that is the time between the entrance of the parasite into the body and the development of symptoms may be as short as seven days but may be anything up to one month.

In the early stages there are no striking symptoms. The appetite may not be so good as usual and the milk yield slightly decreased. There is a rise of temperature but this may easily be overlooked unless the thermometer is used. The animal does not look very ill and the owner usually thinks that the slight decrease in milk yield and slight loss of appetite is due to change

of climate, change of food, etc., and takes little notice. In mild cases these symptoms may continue for some time, the appetite becomes more capricious, the milk yield continues to decrease and there is a loss of condition. The urine may or may not be red in colour.

Such cases may end in recovery after a variable time without any special treatment but there is a marked loss of condition which is recovered very slowly and the milk yield is very much decreased. Such cows although they recover are often difficult to get in calf and may become quite unprofitable to their owners. In severe cases the early symptoms are soon succeeded by serious illness. The breathing is considerably accelerated, the appetite is completely lost, there is usually severe constipation, the urine becomes red or almost black in colour. Such severe cases usually end in death unless treated quickly.

The second parasite common in Ceylon is *Anaplasma marginale*, this is a small round parasite like a dot found inside the red corpuscles usually close to the edge. The incubation period is considerably longer than in the case of *Piroplasma bigeminum* and may be as long as one to two months.

As in the case of *Piroplasma bigeminum* the illness commences with a rise of temperature without any very marked symptoms and is easily overlooked unless the thermometer is used. Red colouration of the urine is never produced by this parasite. The striking features are rapidly developed anaemia and jaundice, constipation with yellow coloured fæces although in some rare cases there is diarrhœa. In most cases the affected cattle show an intense desire to eat sand or earth and if taken outside the shed will immediately lick and swallow great quantities of any dry sand or dusty earth which may be within reach.

There is a very rapid loss of condition and marked decrease in the milk yield. The coat becomes dry and staring and the skin 'hidebound'. This disease is not by any means so common as "Red-water" but is if anything more severe and more likely to end fatally.

The third parasite is known as *Theileria mutans*, a small rod or ring-shaped parasite found in the red corpuscles. This is a very common parasite in Ceylon cattle and as a rule is much less severe in its effects than the two already described. As a

rule it does not cause death. It is characterised by an intermittent fever of long duration with anaemia, loss of condition, and decrease in milk yield. It does not cause red discolouration of the urine.

There is reason to believe that this parasite is responsible for much of the unthriftiness, slow rate of growth and poor development of many young cattle of European or Australian breed in the low-country. While it is true that in the vast majority of cases this parasite does not cause serious illness or death, occasionally very severe and fatal cases occur especially in imported cattle. These occasional severe cases resemble in many respects the deadly East Coast Fever of Africa which is caused by a closely related parasite.

Control of Tick-borne Diseases.—The best method of control is by destruction of the ticks which are the transmitting agents. The best agent for tick destruction is an arsenical solution such as Cooper's Cattle Dip. Where large numbers of cattle are to be dealt with the most economical as well as the most efficient method of using such a solution is by means of a swim dip. Full particulars as regards the structure of these can be obtained from the Veterinary Department.

Where the number of cattle to be treated is not big enough to justify the cost of building a swim bath useful control can be obtained by spraying the solution on to the cattle by means of a spray similar to those used by gardeners for spraying insecticides on to plants. Spraying or dipping to be of use must be done regularly at fixed intervals of a week.

Oily dressings such as mixtures of coconut oil, margosa oil, and kerosene oil are useful for hand dressing of badly infested cattle but are not so effective as the arsenical dip. Where the herd consists entirely of cattle of the local or of Indian breeds the injury caused by these diseases will not be very serious but even such cattle will benefit by being kept free of ticks.

Treatment of Cattle Affected with Tick-borne Diseases.—In these diseases it is particularly important if the best results are to be obtained that treatment should commence at an early stage of the disease. Satisfactory results cannot be obtained if treatment is not started until the disease is advanced and the animal seriously ill. It is a common experience to be called to attend

to cases in the dairies around Colombo at such a late stage of the disease that little can be done. The importance of early recognition of the disease cannot be too strongly stressed. The majority of the cases which one is called upon to treat are in cows recently brought from up-country to the Colombo dairies.

Owners of such dairies can save themselves considerable losses if they will observe the following system. The system is in use at the Government Dairy, Colombo, and has effected a great reduction in the loss of newly purchased up-country cows following their arrival at the dairy.

The system may be summarised as follows:

(1) Immediately the cows arrive at the dairy from the train examine them carefully for young seed ticks. If these are found have them destroyed either by hand picking, dressing with Cooper's Dip or with an oily dressing.

(2) Keep the cows in the shed, do not tie them out on grass under coconut trees. See that the shed is thoroughly clean and free from ticks.

(3) From the day the cows arrive until at least a month afterwards take the temperature morning and evening and note it on a sheet of paper. Any rise of temperature over 102·5° F. should be regarded with suspicion. The cow will not look ill and the temptation to attribute the rise in temperature to some other causes should be resisted.

(4) When the rise in temperature occurs and before the cow looks ill or refuses her food make two or three blood films and send to the Veterinary Department office for examination. Any cattle owner can have the method of making blood films explained and glass slides supplied if he will call at the Veterinary Department office.

(5) While awaiting the result of examination of the slides keep the cow comfortable, give a good bed of straw and if the nights are chilly cover the cow with a gunny bag. If there is any tendency to constipation give the following: Epsom salts ½ lb., Glauber salts ½ lb., green ginger juice ½ a teacupful, water 2 bottles, or perhaps better than the Epsom and Glauber salts is 1 lb. of common table salt plus the green ginger juice and water.

Should examination of the blood films show that *Piroplasma bigeminum* is present an intravenous injection of a drug known as Trypan blue should be given at once. This can be done by the Veterinary Officer. If given early the results are extremely satisfactory and a quick return to normal health can be looked for with confidence.

If the examination shows that *Anaplasma marginale* is the cause of the trouble the prognosis is not so good as in the case of *Piroplasma bigeminum*. Many drugs have been tried. Trypan blue is of no value for this parasite. The best results so far have been obtained by injecting Novarsenobillon intravenously and this should be done at once. The bowels must be kept open and in this disease common table salt appears to be better than Epsom or Glauber salts. Careful nursing and stimulants such as arrack and ginger if signs of collapse are shown.

In the case of *Theileria mutans* infection no specific drug has been discovered as yet. Novarsenobillon appears to be of some value. Nutritious feeding and careful nursing are very important.

In all these diseases there is considerable destruction of the red cells of the blood and tonics are of value in the convalescent stages such for example as Sulphate of Iron in half drachm doses each day, powdered Nux Vomica half drachm to one drachm per day. Water *ad lib*. should be given in all these diseases. If the temperature is very high Sodium Salicylate is useful and this may be given two or three times a day in heaped teaspoonful doses.

The first month or two after an up-country cow is brought to the low-country is a very critical period. Taking the temperature morning and evening and acting immediately a rise occurs will save much loss. Owners cannot be too careful at this time, the purchase and regular use of a thermometer will be found to be a very good investment.

THE DEVELOPMENT OF FIELD EXPERIMENTS IN AGRICULTURAL RESEARCH—PART II

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THE PERIOD OF EXPANSION, 1900-1923

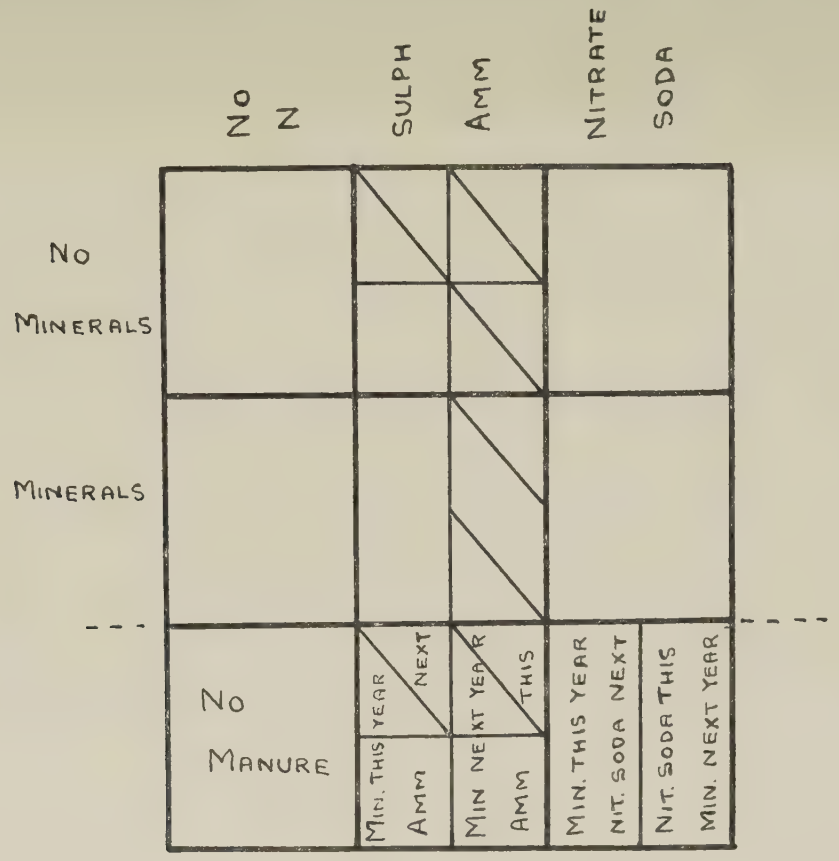
THE work of Lawes and Gilbert stimulated interest in agricultural experiments in many parts of the world. In England, after the death of the Harpenden pioneers, the classical work at Rothamsted continued, but no important development resulted until the second decade of the century when more land became available through the help of the Development Commission in 1911. Agricultural colleges and farm institutes entered the experimental field, but with few exceptions, such as at Cockle Park, their efforts were not conceived on the same scale or with the same precision as at Rothamsted. The war, though it provided new problems in crop production, depleted the personnel of agricultural investigators, and thus militated against progress.

In the United States of America activity was more remarkable. Experiment Stations sprang up in a great many states, and much time and energy was devoted to field experiments. The incentive of the Rothamsted work is undeniable, but the American Stations embarked on a wider sphere of experimentation than had been customary in England. Every conceivable type of cultural and varietal experiment is to be found in the early records of the American Stations, but nowhere is there the same evidence of continuity as at Rothamsted. It was inevitable that in a country that was new in the agricultural sense, where there were many pressing problems, the satisfactory solution of these problems could not keep pace with the continual expansion of agricultural effort. The urgent demand for specific information led to the institution of short time experiments, the results of which were frequently contradictory. The volume of this work can be judged from the fact that, in the 'eighties of

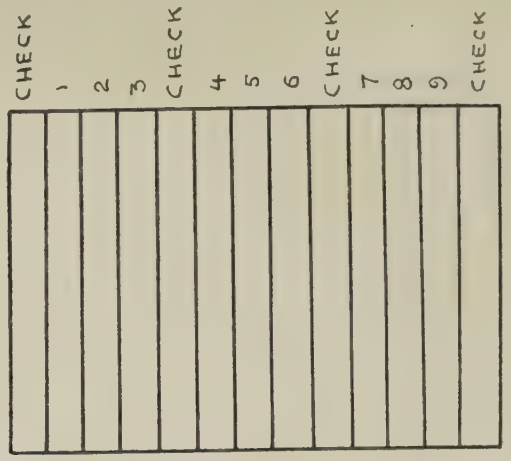
last century, the Experimental Station Record was started, to give abstract reports of the published results from the many stations already in existence.

By the beginning of the present century it was beginning to be realised that the promise of clear-cut guidance from the multifarious field experiments was not being fulfilled, and this gave rise to dissatisfaction with field experimental methods. American commentators of that time are commendably candid about the state of affairs. Piper and Stevenson [15] in a paper on the standardisation of field experiments, in 1909, suggest that though in the past the large sources of error in field experiments had been recognised, the difficulty of such experiments had exercised a retrogressive influence on those whose work it was to carry them out. In short, experimentalists had become unnecessarily careless in their technique. They had reached an impasse, for whilst they admitted the existence of formidable obstacles to accurate experimentation, they were undecided as to what steps to take to mend matters. This was the state of affairs when in 1907 the Journal of the American Society of Agronomy commenced publication, and led the way in the study of more refined methods of experiment.

In the immediately succeeding years, whilst agronomists were casting about for a solution to their difficulties, a number of workers in widely scattered centres were considering a new method of approach, the use of the theory of probability in the interpretation of divergent results in agricultural trials. To whom priority should be given is not clear. At first an approximate methods was used, and Egorov [16] in Russia employed the mean deviation of plot yield as a measure of heterogeneity. He studied reduction in error as plot sizes increased from one to 120 units of approximately 50 square feet (one square sazhen). His results were published in 1909. Wood and Stratton [17] in 1910 gave the first explanatory statement of field errors in England, and this was followed by Hall and Russell [18] in 1911, by Mercer and Hall [19] in the same year, and by continental workers later. Kostecki [20], Fröhlich [21], Frischauf [22], Lehn [23], Gregoire [24], and in Japan, Miyake [25], had all examined the method of least squares in relationship to agricultural experiments, particularly in variety trials, between 1912 and 1916. Of these papers, those of Wood and Stratton and Mercer and Hall had the greatest effect on subsequent progress, the latter to a



Cross-dressing Lay-out
Woburn
Barred Plots have had Lime



Check-Plot Lay-out

B	A	C	D
C	D	A	B
D	C	B	A
A	B	D	C

4 x 4 Latin Square

large extent because of the practical application of the results through the collaboration of "Student". For the moment the history of these early attempts to apply statistical method is all that concerns us, but Student's work whilst amongst the earliest, had an aspect of modernity that makes it the link between the earlier and the later development in method; and because of its great importance its consideration will occupy a separate section later.

Wood and Stratton, (*loc. cit.*) set out to examine the general magnitude of crop experimental errors and their relation to size. By combining small plots on a uniformity trial of mangolds, they concluded that 1/80 acre represented an optimum size; and that for ranges larger than that there was no correlation between size and error. From 200 pairs of similarly treated plots drawn from crops of wheat, barley, oats, mangolds, swedes, potatoes and seed-hay they assessed the average probable error per plot as 5 per cent. a value which agreed with that for optimum plot size from the detailed mangold experiment. In the light of subsequent work they undoubtedly underestimated the plot variability, for their comparisons were based upon a larger number of plots than it is usual to find in a single agricultural trial. This however affected the permanent value of their contribution to the subject but little, for they had focussed attention on plot errors, and they had laid the foundation of replication as the remedy.

Mercer and Hall re-emphasized the necessity for careful choice of land and further explored useful plot sizes. They were not so fortunate as Wood and Stratton in their diminution of error with increasing size, and they recommended 1/40 acre as the standard optimum size. They too were optimistic in their estimate of ultimate error values, suggesting that a fivefold replication would give errors below two per cent. on land judged to be suitable for experimental purposes. In conjunction with Wood and Stratton they were responsible for the replacement of large or single plots, by small replicated units.

THE CHECK PLOT METHOD

At this time the main contribution from the American Stations was the development of the check plot. There was much activity in varietal work, and the changes that could be rung on the varietal theme were more extensive than with

manurial treatments. Faced with a continually expanding list of varieties in cereals, and discontented with the old single plot methods, the experiment stations tried to combine control of heterogeneity with economy of plots by replication of standard check plots. The general principle was to arrange that at intervals of three, four or five plots, a repetition of a standard variety should occur to which all comparisons should be referred. This method of multiple controls was first used in Sweden by Holtsmark and Larsen [26] with check plots every third plot. They used the three nearest controls as the basis for their comparisons and corrected this average by reference to the average of all controls. Leidner [27] and his colleagues also favoured multiple control plots, though they concluded, after trial of this and other methods, that the ideal method had yet to be found. There is evidence of a considerable variety of methods of interpretation. In some cases attention was restricted to the two checks lying on either side of the specific variety. The assumption was made that fertility gradient between check plots was uniform. A simple formula based on this hypothesis allowed the potential fertility of the intermediate plots to be calculated, and this hypothetical plot value was used as a correction.

In other cases the correction for fertility was made more general by taking into account variation over the whole area. For any particular variety the correction was the difference between the nearest check yield and the average check yield. The sign was positive or negative according as the yield of variety was below or above the average check yield [28].

The disadvantages of these methods far outweighed their advantages. In the first place, comparisons could only be made through the appropriate check variety instead of directly. Further, the yields were entirely hypothetical; they represented nothing real. Most serious of all is the objection that after correcting, one has no criterion of the errors of correction. It is far from satisfactory to try and reduce one source of error by introducing yet another, even though the expectation is that the second error will normally be smaller.

Gradually the concept of replication of all varieties made its way into the technique. Pritchard [29] combined the system of alternate checks with a replication of other varieties as high as tenfold. Such a plan besides being wasteful of space takes

no account of the fact that the mean check yield from which all corrections and comparisons derive will be estimated with far greater accuracy than the rest of the experimental yields.

When statistical formulae were applied to results from the check plot method, Kiesselbach [30] plainly showed its deficiencies. He investigated the question of optimum spacing of checks using checks alternately, every second, and every third plot.

He found that there was much variation in his calculated errors, and that checks every third plot gave lower errors than when closer spacing was adopted He concluded that these anomalous results invalidated the method, and made a strong plea for replication as the mainstay of experimental accuracy.

THE ROD ROW METHOD

The multiplicity of experimental plots led to an exploration of further means of saving time and labour in the collection of data. Experiments, chiefly associated with the name of Arny, were made to test the efficacy of sampling small areas on standard plots, instead of harvesting whole plot areas. The result was a development of the rod row method in all its various forms (Arny and Garber, [31] Arny and Steinmetz [32], Hayes and Arny [33]).

Arny and Garber took regularly arranged rows, one rod in length, within each plot. They had nine in all, and considered them in groups of 9, 5 and 4. They assessed the coefficient of variability of the data resulting from these groupings, and concluded that the nine row sample provided a sufficiently accurate estimate of yield. Later, using square yard samples, Arny and Steinmetz compared the error of yield calculated from a few combined units with that of the main 1/10 acre plots. Although they found it greater for the square yard aggregates, they presumed that by increasing the number of units in the aggregates they could ultimately obtain errors smaller than those from the whole plots. "Student" [34] pointed out the grossly fallacious reasoning employed in this argument, for, reduced to its logical conclusion, it meant that when all but a fraction of the plot was used the errors would be many times less than using the plot itself. Arny and Steinmetz had assumed that increase of size of plot would reduce error in the proportion of $1/\sqrt{n}$ where n was the number of aggregated units, *i.e.*, that increase in size was as effective as increase in replication. On the contrary, because the

variability is not randomly distributed there is a high correlation between adjacent plot yields and the correct reduction is given by the formula $\sqrt{1+\frac{(n-1)r}{n}}$

where r is the correlation between the square yards in the composite plot.

The whole subject of systematic variation in soil heterogeneity was clarified by the work of Harris [35]. He showed that adjacent plots were more likely to yield alike than similar plots scattered about an area, and for a variety of crops he calculated the correlations, calling them the coefficient of heterogeneity, from the formula

$$r_{p_1 p_2} = \left\{ \frac{S(C_n^2) - S(p^2)/m\ [n(n-1)]}{\sigma_p^2} \right\} - p^2$$

where C_n is the yield of large plots of p units.
m the number of large plots considered
σ_p the σ of the ultimate in units.
S is the summation symbol.

The existence of this correlation is ubiquitous. Maskell [36] has tabulated its value for a number of crops, and for the soil characteristics of moisture content, carbon and nitrogen content. His values range from +·317 to +·830. Harris' work gravely discredited much of the technique used in connection with rod row estimates of yield, and not until Clapham [37] with the advantages of later researches at his disposal re-investiaged its possibilities were the advantages of sampling yields restored to favour.

BORDER EFFECTS

Although check plot and rod row methods contained inherently grave defects it would be untrue to suggest that their development contributed little to the advance of experimental technique. They threw into high relief the problems of soil heterogeneity, plot shape and plot size, and if for a time no satisfactory synthesis could be built up from the manifold analytical data they produced, still they played an important part in preparing the way. One important contribution was the study of border effects. The general acceptance of small plots made the unrepresentative character of the outside rows a serious matter. With varietal grain trials, overshadowing of short

strawed crops by long ones proved to be a source of interference, and the greater root range at the edge of uncropped paths sometimes gave certain varieties special advantages. Arny and Hayes [38] found that by discarding two border rows the rank of their varietal yields was in some cases changed significantly. Arny [39] adopted the system of cropping the alleys, without however including those rows in yield measurements. Where winter wheat was cropped with alleys of spring wheat, the effect was satisfactory, but not when oats or barley was used as the dividing crop. The only satisfactory way of avoiding border effect whether from uncropped alleys, or different rooting capacity of alley crop and main crops was to discard outside rows. In many experiments this meant planting as many guard rows as yield rows. Arny [40] recommended sacrificing three rows.

The trouble with border effects was accentuated by the trend of opinion regarding plot shape. Long narrow plots were convenient for management, but gave a disproportionate perimeter for a given area. They were also favourably looked upon from the point of view of error reduction, though there was some conflict of evidence. Love [41] Spragg [42] and Summerby [43] in their researches into technique supported long plots. Day [44] reached the heart of the problem when he brought in the consideration of the direction of the fertility slope. He preferred a square plot to a long one having its greatest dimension in the direction of least soil variation, and only recommended the strip plot where the trial plots lay side by side in the direction of least fertility gradient. Summerby's (*loc. cit.*) decision that length decreased error more than increase in width is placed under suspicion because he omitted any reference to the fertility slopes he was dealing with. Later with the advantage of a better statistical technique Christidis [45] showed that theoretical consideration in favour of long plots was fully borne out by practical examples, but he did not consider the complications of border effects.

There is much repetition in the American work but its cumulative effect was to emphasise the importance of replication of small plots. This brought in its wake other sources of error not recognised at first but subsequently brought to light and remedied. The fact of soil heterogeneity was readily admitted, and overshadowed every other consideration, but though Mercer

and Hall had pointed the way, the technique that had grown out of their work in the second decade of the century was satisfactory neither to the statistician nor the experimentalist.

THE MODERN STATISTICAL PERIOD

The modern statistical period does not fall neatly into a clearly defined section of time. In sketching out the chronological sequence of events, some of these have only a temporary significance, whilst others, not at the time fully appreciated, fall into a truer perspective later. This has been so in the realm of experimental technique, so that in studying the modern period it is more advantageous to regard the subject from the point of view of the unfolding or fruition of a method, without undue adherence to the actual sequence of events.

STATISTICAL METHODS RELATED TO DESIGN OF EXPERIMENTS

What distinguishes this period from its forerunner is the fact that, previously, statistical conceptions had been applied to field experiments as an accessory. Statistical methods had been elaborated outside the sphere of agricultural science. When use was made of them it was as a last stage in the development of the experimental plan. It might be true to say that no experiment was complete without them, and that every agronomist was expected to make use of them, but the statistical procedure was something apart, a veneer that gave a polish, not something that penetrated to the very core.

The new viewpoint puts statistical procedure in an entirely different place. From the very first stages of an experimental project, the statistical method has to be borne in mind; the mathematical process must fit the data that are to be gathered, and the experimental design must be in accordance with the statistical procedure.

There is an element of danger in this development inasmuch as it can easily lead to statistical method becoming an end in itself. Statistics is an ancillary weapon, but under the new auspices it has become a weapon that has a rightful place in a permanent armoury.

The modern viewpoint then demands three things; a valid statistical procedure, a design that conforms to this procedure; and a criterion of significance of results as a basis of interpretation. It is remarkable that at the time of Mercer and Hall's

fundamental researches these three desiderata were in the main fulfilled by Student.

STUDENT'S METHOD

In 1908 Student had taken the first step towards solving the problem of the application of the theory of probability to small samples [46]. What in effect he did was to investigate the standard deviation of a population of which he had only a small sample. The true standard deviation of the population was unknown, but the experimental data provided an estimate of it. "Student" studied the distribution of this estimated standard deviation, and showed that it agreed with the true distribution for those statistics generally used in comparison of means, and Fisher [47] later extended its application to cover the higher statistical derivatives.

Student thus provided a valid statistical procedure and an appropriate criterion of significance (Student's z). In an appendix to Mercer and Hall's paper (*loc. cit.*), he elaborated a field experimental design that was appropriate to his processes.

The classical example of Student's design is an experiment to test the yield capacities of two varieties of wheat. He postulated that these should be sown in the experimental field in alternate strips, allowing an equal number for each variety. Before harvesting, each of these strips was bisected longitudinally, thus doubling the original number of plots. The two outer half strips were discarded, so that from n original plots he produced n—1 comparisons for the estimate of yield differences, in place of the $\frac{n}{2}$ that were available from the original siderations in favour of long plots was fully borne out by practical plots. Labelling the varieties A and B the sequence of the half strips became A B B A A B B A. Now considering two adjacent half strips as a unit, this arrangement provided that if there were a steady fertility gradient across the strips neither variety would be favoured. The mean difference between A & B is calculable from the sum of the differences between A and B in each unit separately, and the only effect that systematic cross fertility gradient has on mean differences, is what is encountered within the narrow confines of the double half strip unit.

In calculating the errors of the experiment, the differences between varieties A and B for each unit were tabulated and the standard error of the mean difference evaluated from these

data. The striking accomplishment of this design was that mean differences, from which fertility or positional advantages had been largely eliminated, were interpreted with reference to an error from which the disturbing influence of these same positional factors had been consciously removed also. This was the first occasion on which the correlation between nearly adjacent plots was turned to advantage by using it to overcome the fertility gradient that had been such a handicap to the American workers.

Advantage was taken of Student's arrangement for comparing two varieties by Beaven [48] who in his half-drill strip method ingeniously arranged that the drilling of the two varieties in the required order should be done by the same drill. The seed hopper was divided into two compartments served by the same number of coulters, one division for each variety. The sowing of the plots thus became a simple continuous operation, since on turning the drill the order of the varieties was reversed. Beaven used this plan in 1920 and it was adopted as a standard procedure by the National Institute of Agricultural Botany in 1923. In the same year it found in America an advocate in Love [49] who remarks that "this method has been little used in interpreting experimental work. Probably it has been overlooked".

It is convenient to mention here that when Student's work received due recognition, the statistical processes used in his original exposition were frequently divorced from the niceties of his design. The statistical calculation became known as "Student's method" which is somewhat of a misnomer. With popularity came misconception, examples of which will be discussed later.

THE ANALYSIS OF VARIANCE

For a single comparison the "method" is simplicity itself, but in applying it to trials involving a relatively large number of comparisons the complexity is vastly increased. Student [34] extended his investigations to a trial of eight varieties replicated twentyfold in a regular chess board arrangement, and, in order to derive an error common to the whole experiment, he estimated the error of the mean difference for every combination of possible pairs, 28 in all. In seeking to simplify the arithmetical calculation he divided the variation encountered within the experiment

into a number of parts due respectively to differences in variety, differences in position of his replicated groups of varieties on variable blocks of land, and finally casual variation or error.

At the same time, and independently, Fisher had seen the possibilities of subdividing variation in the same way. The simplicity of Fisher's formula and working have resulted in his method superseding Student's, so that consideration can be confined to the former's statement of the problem.

The Analysis of Variance, to give it the name that Fisher suggested, postulates that if a number of data are arranged in a number of classes containing an equal number of observations in each class, then the total variance about the general mean is divisible into two parts; that which is represented by sums of squares of deviations of individuals in the groups from their own group mean, and that represented by the deviations of the group means from the general mean.

If there are n^1 classes and each has in it k individuals then from the point of view of sums of squares of deviations the following identity holds good [50].

$$\sum_{1}^{kn^1}(x-\bar{x})^2 = k\sum_{1}^{n^1}(\bar{x}_p-\bar{x})^2 + \sum_{1}^{kn^1}(x-\bar{x}_p)^2$$

S is the summation symbol.

x is any datum.

$\bar{x}$ is the general mean.

$\bar{x}_p$ is the mean of a particular one of the n^1 groups.

From the sums of squares of deviations a mean square or variance is derived by dividing by the number of degrees of freedom, one less than the number in each variance class. This variance is the square of the standard deviation of that particular class.

The analysis may be tabulated as follows:

	Degrees of freedom	Sum of squares	Mean square
		kn^1	kn^1
Within classes	$n^1(K-1)$	$S(x-\bar{x}_p)^2$	$S(x-\bar{x}_p)^2/n^1(k-1)$
		1	
		n^1	n^1
Between classes	n^1-1	$kS(\bar{x}_p-\bar{x})^2$	$kS(\bar{x}-\bar{x})^2/n^1-1$
		kn^1	kn^1
Total	n^1k-1	$S(x-\bar{x})^2$	$S(x-\bar{x})^2/n^1k-1$
		1	1

All these functions are directly determinable from the original data and the mean square for within classes provides an efficient error from which to assess the reliability of differences between class means. The closer examination of the underlying statistical theory has been carried out by Irwin [51], [52].

The principle is capable of extension. A number of data may be classified in more than one way. For example, in a varietal experiment with crops, such as Student examined, the data may be classified in the form of the eight varietal means, and also in the form of the twenty means of the replicate blocks. There is an each to each correspondence; all varieties occur in all replications; each replication contains all varieties. Reduced to the appropriate standards such an experiment analyses as follows:

	Degrees of freedom	Sums of squares
Between varieties	7	a
Between blocks	19	b
Remainder	133	c
Total	159	d

The remainder, which is in reality an interaction between varieties and blocks, measures the deviations from the assumption that yield of any plot can be expressed as the sum of an intrinsic varietal factor and an intrinsic block fertility factor.

It is therefore a measure of consistency in varietal response, and is the error to which varietal differences can be referred. It can be calculated by difference when the other three values have been calculated directly.

The advantages of this method are many and varied. First in order of importance from the point of view of field experiments is the control of local fertility differences. The arrangement of chess board experiments into blocks each containing a member of all varieties or treatments to be tested, makes *ipso facto* a distinction between the degree of soil variation to which varieties in the same block or in different blocks is subject. If the replicates of a single variety are used as the basis for error evaluation, the resultant error figure will be affected by gross variation from block to block. The comparison of two varieties for which such error figures are available will be further complicated by the fact that using the formula

$$\sigma^2_{A-B} = \sigma^2_{A} + \sigma^2_{B}$$

the independance of the variables is assumed. Now the mean difference between two varieties is calculable from the sum of the individual differences block by block, and these are unaffected by the gross block differences. Consequently, by this method which was at one time commonly used, mean differences, into which block variation does not enter, are judged by reference to an error into which block variation does enter. By taking precautions to plan the experimental layout and the statistical procedure in concert, this anomaly can be avoided. The resultant gain in precision when gross block variance is eliminated before making the estimate of error has been demonstrated by Eden and Fisher [53]. In their experiments, examples were obtained of a more than fourfold increase in precision.

The analysis of variance, used with adequately designed experiments, provides another advantage. When systematic variance due to treatment and position have been eliminated, the remaining variance contributions between parallel plots can be pooled irrespective of the treatment or block from which they ultimately derive This gives a greater number of degrees of freedom for error estimation, and hence increased accuracy; and it provides one error figure relevant to any treatment or varietal comparison included in the experimental design.

One of the first attempts to eliminate positional variance was based upon a design called the Latin Square [54]. In this the number of replications equalled the number of treatments. The actual layout as shown in the accompanying diagram provided that each row and each column contained each of the treatments. Under these circumstances comparison of means of rows and means of columns represented positional variation unaffected by treatments. It was thus possible to eliminate gross positional variance in two directions at right angles to one another, so that the untoward effect of fertility gradient in any direction was largely eliminated from both means and errors.

The analysis of variance has so far been viewed in the light of developments from Student's position. There was one fundamental difference that Fisher insisted on, that within replications, the order of treatments should be random. Where this is impossible as in the Latin Square, a large element of randomness can still be obtained, any given square being a random choice from the total possible number. Yates [55] has enumerated all the possible types of square up to 6×6. Tedin [56] has confirmed the necessity of randomisation by showing that systematic or planned arrangements affect error values to a sufficient extent to invalidate their use in subsequent interpretation.

In concluding this exposition of the use of the analysis of variance for control of local soil variation, it is of interest to set out the scheme of Student's original strip experiment and to interpret it in terms of Fisher's analysis.

Let us take two varieties A and B replicated twenty times. Student's procedure was to set down the yields and to analyse them as follows:

		Difference	Deviation from mean	Deviation squared
A	B	A − B		
a_1	b_1	$a_1 - b_1$	d_1	d_1^2
a_2	b_2	$a_2 - b_2$	d_2	d_2^2
.	.			
.	.			
a_{20}	b_{20}	$a_{20} - b_{20}$	d_{20}	d^2_{20}
		Total		Sum
		Mean		

It is seen that there were twenty squares to sum providing nineteen degrees of freedom.

The Fisherian analysis would be of the form

	df.	S.S.
Between varieties A & B	1	a
Between replications	19	b
Error. Interaction V × R.	19	c
Total	39	d

Student's error figure for the S.E. of the mean difference is identical with that derived from the interaction of variety and replication c when the latter is reduced to terms of a difference between two means of twenty. The formulae are

$$\frac{\text{Student}}{\text{Difference S.S.}}{19 \times 20} = \frac{\text{Fisher}}{2 \times \text{Interaction S.S.}}{19 \times 20}$$

If Student's strips had been arranged in random order with respect to position of A and B within the replication unit, his error valuation would have provided the first example of a randomised block experiment interpreted on the lines of modern statistical methods.

MISAPPLICATIONS OF STUDENT'S METHOD

In America particularly, there grew up a tendency to believe that Student's method was applicable to all types of data and that the interpretation of field experiments could be based entirely upon examination in that way. This rigid adherence to the method still holds in some modern experiments, and, with the parallel process of the analysis of variance at our disposal, it is possible to point out and resolve some of the difficulties that have cropped up.

Salmon's [57] criticism of the method as used in America is acute and generally reasonable, though his papers on the whole give the impression that he deprecates statistical analyses in general. Arguing from single plots devoted to two different treatments over a period of years, he was the first to suggest that "Student's method" often gave an interpretation in conflict with common-sense. Thus a series of A-B differences might all be positive, and yet because of their marked variability, the

variance of the difference might be high enough to discount the reality of the mean difference. The trouble in such cases is that the variance so estimated may be due either to random causes or to differential response of treatments in a number of different years. In the absence of a more complete analysis, to which in any case a single plot experiment does not lend itself, the method must often give negative results, not because it is faulty, but because it is not designed to answer the detailed question that has sometimes been asked of it. In a replicated experiment it would be possible to compare this differential variance (or interaction) between season and treatment with casual errors. In many cases the result is negative because, admitting that seasonal differences in response may be likely, the tenure of the experiment is not long enough to decide with accuracy whether, on the whole, one treatment turns out better than another. This is a difficulty that the original Rothamsted experiments with their long duration completely avoided. Salmon also pointed out that a significant result obtained by this method could be validly accounted for on the assumption that the tract of land relegated to one of the treatments was intrinsically better than that allotted to the other. Again in the absence of replications the matter is left in doubt.

Salmon dealing with experiments of the single plot per treatment type could give no formal demonstration of his contention, but the point is well illustrated by data from the Dutch East Indies on both rubber and tea experiments. Barclay and Grantham [58] have recently shown that, for rubber, monthly yield differences between two treatments when used as a basis for calculating error by "Student's method" give lower error figures than when the error is derived from an analysis of replicates. They rightly say that the fact that an error figure assessed by a method which gives a lower value than an alternative method, is not necessarily an indication of its validity; but they do not show how the two error figures are related. The following example is based upon figures given by Prillwitz [59] for a uniformity trial on tea. Two hypothetical treatments A and B were replicated sixfold in pairs. Monthly yields were taken for a period of six months, and an error calculated on the basis of monthly differences of the totals of the six replications.

The full analysis is as follows:

	df.	S.S.	M.S.
Treatment (Hypothetical)	1	2·7	2·7
Blocks	5	7282·8	1456·56
Months	5	20767·5	4153·50
Treatment × Blocks	5	1910·0	382·00
Treatment × months	5	345·6	69·12
Blocks × months	25	4570·2	182·81
Treatment × blocks × months	25	3346·7	133·87
Total	71	38225·5	

As calculated from the monthly totals the error mean square is 69·12, and represents the interaction of treatment and months. This is a much lower figure than 382·00 which is the interaction of treatment and blocks. The latter is the valid error for comparing treatment differences as a whole, and its use prevents the misinterpretation noted by Salmon, due to there being intrinsic differences between the plot or plots assigned to one treatment, that have nothing to do with treatment. The other figure merely provides a test for the consistency of monthly yields. Bearing in mind the fact that tea is a perennial crop, it is not surprising to find that a given bush or plot behaves similarly in successive months irrespective of treatment. A similar analysis in Eden's [60] data again shows a much smaller time interaction than block interaction.

SEASONAL VARIABILITY

The misuse of statistical interpretation that has just been cited arose from a failure to distinguish between what may be called time or seasonal errors, and those due to soil heterogeneity. Engledow and Yule [61] considered the separation of these effects when the results from a number of varietal trials over a series of years were pooled, or when several sowings in the same year were amalgamated. They do not give a fully worked out example, but the following hypothetical case shows the principle. Supposing that there were three varieties replicated eight times in each of five years (not making use of the same plot sites) a total of 120 plots is given. For the three possible comparisons between the three varieties, (*e.g.*, for varieties A,B,C, these are A – B, A – C, C – A) a sum of squares of deviations is obtained by treating all replicates as of equal standing, irrespective of year, and using the mean for the whole period. This error variance is designated d σ^2 w + g and embodies

variation due to both weather or season, and ground or soil. A further sum of squares taken from the mean of each year separately and summed over the three years is used for estimating d σ^2 g the variance for ground only.

From the relationship

$$d\sigma^2 w = d\sigma^2 w + g \quad d\sigma^2 g$$

an error for weather is arrived at.

Looking at the problem from the standpoint of the analysis of variance the groups into which the variance divides are:

	df.	
Varieties	2	
Blocks	35	
Years	4	}
Varieties × years	8	}
Remainder	70	
Total	119	

The difference between the *sums of squares* estimated according to the scheme outlined above would give a sum of squares combining differences between years, and interaction between varieties and years. But to compare differences between varieties over the three-year period with an "error" for weather it is appropriate only to use the variance for the variety-year interaction, for, according to the design of the experiment, every variety being tested in each year, the gross effect of year is removed.

Engledow and Yule's work emphasized the fact that an experiment done in one place or one season has a limited inductive basis, and that before the general superiority of a variety or treatment is assumed, treatments must be tried under a number of different climatic conditions. The analysis of variance affords a simple and straightforward way of doing this by means of standard experiments carried out over series of years. The general consistency of varietal behaviour can then be judged in conjunction with the appropriate error variance (variety × year) and further the significance of any apparent differential response of varieties to different climates can be tested by comparing (variety × year) with the higher order interaction of the remainder.

(*To be continued*).

USE OF KIKUYU GRASS IN COMBATING SOIL EROSION*

IN the great anti-soil erosion campaign, the construction of dams, to serve as drinking places for stock, is an extremely important measure, since it strikes at the very root of the evil, viz., the tramping out of the veld. The efficacy of a dam, of course, depends, amongst other things, upon how long it will be able to store sufficient water to serve as a drinking place, and in this connection silt plays an important part, especially in those areas of the country which are subject to erosion and where the need for a greater number of drinking places is most felt. In such areas flood waters usually carry a high percentage of silt, as a result of which the silting up of dams becomes a serious problem. Yet on the other hand, it is desirable to have dongas silted up. That it is possible to make the dongas silt up at comparatively small cost, without getting the same result in the dams, has been demonstrated in a convincing manner by Mr. W. C. Kritzinger, of Glen Roy, P. O. Commadagga, whose farm is situated in the Karroo area, Somerset East district, where the mean annual rainfall is 15 inches. Soil erosion is prevalent in that area, and the water carries a high percentage of silt.

For years past there has been a sloot, 10 feet deep and 25 feet wide, in the valley of Glen Roy, and Mr. Kritzinger decided to construct a dam across it in order to store water for irrigation purposes. The dam was built in the form of a wide U, the wall being 300 yards long and 23 feet high. It was soon realized that unless steps were taken to check silting up of the dam, it would take only a few years before it would be completely silted up. Mr. Kritzinger then set to work as follows: On the up-stream side, a few yards from the spot where the sloot enters the dam, he erected a barrier of wire-netting across the sloot. The barrier consisted of heavy wooden posts, planted about 18 in. deep and anchored to large stones some 2 feet deep, as terminals, with standards 5 feet apart and also thoroughly anchored in between; 6 feet of the wire-netting was placed on the up-stream side of the bed of the sloot, and firmly weighted down with stones. Where the sloot was larger more wire was placed on the bed, and it was more firmly weighted down. As soon as this barrier caught silt, which happened after the first rain, Kikuyu grass was planted there, and another barrier was erected in the same way about 50 yards higher up the sloot. Kikuyu grass was also planted here after the first silt deposit. In this way Mr. Kritzinger worked further and further up the valley, and his results exceeded all expectations.

BINDING POWER OF KIKUYU GRASS

Although an average annual rainfall of 15 inches is too small under ordinary circumstances for the successful establishment of Kikuyu grass, the conditions in this scheme were very favourable for the grass, since it was

* By J. A. van Rensburg, Extension Officer, Bedford, in "Farming in South Africa" Vol. X, 106 of January, 1935.

planted on fertile alluvial soil in a watercourse. In these circumstances the grass rooted readily and spread so rapidly that by the time the organic matter which was washed up against the barrier and dammed up the silt was decomposed, the Kikuyu was able to bind the soil, which would otherwise have been washed away once more, as is the case with wire-netting barriers where no Kikuyu grass is planted. The success of this method is attributable to the enormous soil-binding power of Kikuyu grass. Instead of injuring the grass, the soil deposited on it by the subsequent rains served as a top-dressing, as a result of which the grass grew with renewed vigour.

The undertaking was an absolute success, and the results were better than had been expected. The quantity of silt deposited in the dam soon diminished, until after a few years no more silt entered the dam. The sloot of 10 ft. by 25 ft. which had previously drained the valuable valley and carried away the fertile soil, has been silted up for a distance of 1½ miles, and the entire length is covered with a strip of Kikuyu grass averaging 50 yards in width, so that the terrain of the previous sloot has been changed into valuable grazing with a carrying capacity almost ten times as high as that of the natural grazing. This is indeed a splendid recommendation for this grass as a measure to protect the soil against the ravages of soil erosion.

PRACTICAL DUCK-KEEPING*

IN Queensland, ducks are chiefly kept for table purposes, although quite a number of small flocks are kept for egg-production. There are very few specialised duck farms; the usual practice is to keep a flock of ducks as a farm sideline. The market for table birds is usually kept fairly well supplied from existing sources, high values are therefore not regular. Reasonably high prices are, however, obtainable when the demand is firming for the Christmas trade. This fact indicates the necessity for the table. The keeping of ducks for egg-production is not practised extensively in this State; this is possibly due to the unpopularity of the duck egg, making it somewhat difficult to market. It is all a question of taste, for a duck egg is equal to a hen egg in food value, and provided the birds are fed on good wholesome food and kept under strict sanitary conditions, it would be fairly difficult to distinguish any difference in general quality. Ducks are more prolific layers, have a longer profitable life, are more easily reared and are freer from disease than other poultry.

The foremost breed is the Muscovy; this bird is essentially a table bird, and may be found all over the State. The Muscovy is distinct from all other breeds of ducks and will always remain distinct, for if this breed is crossed with any other breed of ducks the progeny will be mule ducks.

THE MUSCOVY

GENERAL CHARACTERISTICS

The head is large, and at times it raises the feathers in fan shape; the beak is thick, with a band of reddish colour, the nostrils and the face being covered by carunculated flesh; the eye is brown; the neck is thick and of a fair length. The body is a great frame, rectangular in shape and nearly horizontal, short and powerful in leg, with fairly large feet, webbed to end of toe with powerful claws. The male has no curled feathers in the tail, as other breeds; his plumage is of a brilliant bronzy black, with a green sheen. Legs of both sexes are black to the toes.

The female is similar to the male, but only half the size, without the wrinkled flesh around face, and duller in plumage than the male

SIZE

The average weight of the drake is just over 12 lb., but many reach 14 lb. and over. The duck, however, is less than half the weight of the drake, and it is a very large duck which attains 6½ lb., the average being about 5 lb. The adult drake is enormous—measuring frequently 32 to 34 in. in length; it walks slowly and heavily.

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* By J. J. McLachlan, F.B.S.A., Poultry Inspector, in the *Queensland Agricultural Journal*, Vol. XLII, Part 2, 1 August, 1934.

INDIAN RUNNER

GENERAL CHARACTERISTICS

Of the egg-producing ducks, the Indian Runner predominates in numbers. But the Khaki-Campbell is becoming very popular and is equal as a layer, whilst it is slightly heavier in body weight than Runners.

Head.—Fine and somewhat flattened over the skull, with the eyes full bright and clear, showing alertness, and situated high up in the skull. Bill strong and deep at the base where it joins and fits almost insensibly into the skull, and thence comes as nearly as possible straight down to the tip, giving it a wedge-shaped appearance of good average length.

(*Note.*—The shape is more important than actual length or width, and it should be proportionate to the build and size of the bird and well set into the head at the junction. Very flat or dished bills with rounded under-line are objectionable, and abnormally long heavy bills are liable to be accompanied with coarse heads and thick necks, which are serious faults.)

Neck.—Neck very fine, thin and slender to where it begins to form the expansion towards the base of the neck, which expansion should fit almost insensibly into the upper part of the body, so as to appear almost part of it, the head and neck carried high and slightly forward, and not curved or carried swan-like.

Body.—The lower portion of the neck expansion is included—long and narrow, of nearly uniform thickness, very tightly feathered. Wings closely packed; approximately about twice the length of the neck to the top of the head. When standing erect, the stern appears comparatively short and curves round to the tail, which is close and neat, and in the best specimens carried nearly in a line with the body, but in some excellent birds it is slightly elevated or turned upwards, and a fullness of the lower stern is frequent in the most prolific layers.

Legs.—Legs placed much farther back than in other breeds of domestic ducks. Shanks comparatively short, with small supple feet and strong thighs to enable the bird to balance properly and maintain an upright position when on the run.

Length and Size.—As layers of a great number of large eggs, substance and constitution are necessary in the breed; small, square specimens are useless, while heavy bulky birds are less active as foragers and open to the same objections. A medium size with good reach and perfect symmetry is advisable, but appearance and activity should be a truer guide than actual weight and measurements.

Carriage.—In comparison with other ducks, the body is more tightly feathered and appears longer and thinner, and this impression is heightened by the remarkable erect carriage and the fact that the bird when on the alert carries its neck and body almost in a line at an angle of from 50 to 70 degrees to the horizon. Its gait is peculiar in that it travels with a straight-out run and does not waddle or roll like the ordinary duck. In

general appearance and shape when in motion, it has, not inaptly, been likened to a soda-water bottle set at an angle of 50 to 60 degrees, a character which is best seen in a front or semi-front view. When startled, standing at attention, or trained in the show pen, it assumes an almost perpendicular pose or attitude.

Weight.—Drakes, 3½ lb. to 5 lb.; length 26 inches to 32 inches. Ducks, 3 lb. to 4½ lb.; length 24 inches to 28 inches. The above are fair standard weights and lengths, but must count for nothing if not accompanied with type and well-balanced proportions.

There are three varieties—Fawn, Fawn and White and the White.

THE KHAKI-CAMPBELL DUCK

GENERAL CHARACTERISTICS

This is moderately small breed, the body being wide and fairly deep, with slightly upright carriage and finely shaped head and neck. In the male the bill is green (the darker the better) the head, neck, stern and wing-bar bronze, and the rest of the body an even shade or dark buff, with dark orange legs and feet. In the female the bill is greenish-black, the plumage being khaki or dark buff all over, with even ground colours while the back and wings are laced with á lighter shade of buff, and the legs are dull orange, both bill and legs being several shades darker than in the drake. Lightish feathers in the wings are allowed, but white bibs are untypical, as are yellow bills. Khaki-Campbells are tame and tractable creatures, and prolific layers of white eggs.

Weight.—Both sexes, 4½ lb.

HOUSING

The mild climatic conditions in Queensland obviate the necessity for the construction of elaborate or costly houses for the accommodation of ducks. That does not mean that ducks can be herded profitably in any class of a house. Houses should be built similar in design to ordinary poultry houses, a lean-to building facing north or north-east, open-fronted, with a ventilation space at the top of the back wall. Buildings so constructed will afford the ducks most protection against prevailing winds and rains whilst at the same time the sun's rays penetrate into the house.

Construction.—The building need not be deeper than 5 feet, and the roof could be 6 feet high at the front and 5 feet high at the back, and a ventilation space of 3 inches at the top of the back wall would be satisfactory. In estimating the size of the building, allow 2 square feet of floor space for each duck; thus a building 10 feet long and 5 feet deep will accommodate twenty-five ducks. The best materials for the construction of duck-houses is sawn hardwood and galvanised corrugated iron. Some persons may desire to make use of bush saplings so as to have cheaply constructed buildings; this may be done, but it is essential to have an iron roof. It may be thought that as ducks usually camp out in the open it is unnecessary to have an iron roof, but this is absolutely essential for one of the most important factors in the housing of ducks is a dry floor.

Floors.—It is essential for the floor of the house to be dry at all times, a damp or wet floor in a duck house may cause many deaths among the flock, while practically the whole flock will receive a check in growth or production. To ensure dry floors, build up the floor at least 4 inches above the level of the surrounding land; also excavate drains on the highest side of the house, so as to carry away storm water. Concrete floors are best, but an earth floor that has been tamped down fairly hard will be satisfactory. To facilitate cleaning, cover the floor with coarse sand or a litter of hay, grass or straw. The litter will act as a bedding for the ducks. Nests should be provided. These may be placed on the floor against the walls.

BREEDING

It will be found most profitable to adopt the same breeding season for light-breed ducks as generally adopted for other poultry—namely, June to September. Ducks hatched during these months will commence laying when egg values are high, and continue for about twelve months before moulting. Heavy breeds hatched during June, July and mid-August, will be more profitable, as they can be marketed in prime condition for the Christmas trade. The breeding of heavy breeds may be continued throughout the year, provided that a constant supply of cheap suitable foodstuffs is available.

Selection and Mating.—Care must be exercised in the selection of breeding stock. Special attention must be given to type and size. A careful study of the description of the breed is necessary, so as to be able to select birds that are reasonably true to type. Ducks have a tendency to deteriorate very rapidly in size; therefore, it is essential to maintain size of body when selecting breeding birds. In this regard, it is good policy to weigh the birds before placing them in the breeding pen. Defective ducks should not be used for breeding purposes. In mating, the number of females to mate with each male varies with the age of the male, size of run, whether the birds have access to a swimming pool, and the breed. On an average, mate between six and eight females with each light-breed male, and from four to six females with each heavy-breed male. The number of females may be increased if the male is young and very vigorous. Ducks may be safely bred from until they are three or four years old.

MANAGEMENT

Ducks should be kept apart from fowls, as they are greedy feeders and often prevent the fowls from obtaining sufficient food. Their way of feeding is also slightly different. Apart from these factors, ducks make the drinking water unsuitable for poultry. A swimming pool is not a necessity, but where ducks have access to a pool, they keep in better health, their plumage is cleaner, and they are more free from external parasites. In addition, a higher degree of fertility results if breeding birds have access to a swimming pool. As the duck usually lays in the night or early morning, it is necessary to confine them to the run or house until about 9 a.m., otherwise many eggs may be laid in the pool.

Ducks must have a constant supply of clean, cool, fresh water, and when confined during the night water must be supplied. The water vessel should be deep enough for the duck to submerge its head in the water.

Ducks are naturally clean in their habits, but if confined in a small enclosure not properly drained, filthy conditions will result. Therefore, strict sanitation should be practised.

When kept in large numbers, ducks, particularly Indian Runners, are very excitable and easily frightened, and if frightened they are very liable to go into a partial moult.

INCUBATION

It is the usual practice not to set the first hatch of eggs laid by a duck, these being often infertile; also, if fertile, weak ducklings usually result from such eggs.

The period of incubation is 28 days for all breeds with the exception of Muscovy eggs. These take 35 days to hatch. The incubation of duck eggs is best done with ducks. If broody hens are used, it will be necessary to sprinkle the eggs with water regularly. Also sprinkle water on the glound close to the nest, for when the hen comes off she will dust bath, and her feathers will be moistened when she returns to the nest. The duck, however, will moisten her feathers sufficiently before returning to the nest. With artificial incubation, the temperature should be about 1 degree lower than that for hen eggs—namely 102 degrees. After setting, the eggs should not be disturbed for 48 hours. After this period, they should be turned twice daily, and cooled daily. Each time the eggs are turned, before being returned to the machine, they should be sprinkled with warm water. This sprinkling is essential because the eggs require a lot of moisture. Test, and remove all infertile eggs. Do not open the machine after the ducklings commence chipping until the hatch is complete. Ducklings take longer to break out of the shell than chickens.

REARING

Ducklings are very hardy, and easy to rear, therefore rearing may be done by artificial methods. Any type of a simple brooder that will permit of water being kept within access of the ducks will prove satisfactory. For instance, a frame with four legs about 6 inches high to which is tacked a piece of hessian from which flannels hang to within an inch of the ground will give results. First place ample straw on the floor, put down the brooder; the ducklings should be kept under the brooder the first day without food or water. To confine them, use inch netting close up all around the brooder. By adopting this practice they will know where to go when feeling cold. The following night they may be allowed 8 or 10 inches around the brooder, and in this space place water vessels. After about a week, it will be necessary to confine them to the brooder. After about three weeks the brooder may be removed, providing that ample straw is placed in the shed. One important point must not be overlooked, and that is ground draughts must be prevented. Every day the straw should be forked up and, if necessary, replaced with clean, dry

straw. Ducklings must not be crowded; best results will be obtained by rearing ducklings in small units. When about four weeks old they may be placed out in houses for they do not then require much attention apart from plenty of food and water. Ducklings should be protected from the hot sun until they are well feathered on the head and neck; this is more important with Indian Runners than other breeds. Therefore, the rearing pens should have a number of shade trees growing in them; if not, artificial shade should be provided.

FEEDING

Ducklings require no food for 48 hours after hatching. During this period they could be supplied with water, coarse sand, and charcoal or wood ashes. A mash that will give good results if fed from the first meal until they are about four weeks old is prepared by mixing together pollard, 10 lb.; maizemeal, 8 lb.; dried buttermilk, 2 lb.; bonemeal, ½ lb.; and fine salt, 2 oz. If these ingredients are mixed together the amount for each meal may be moistened as required. If available, 3 lb. of curds would replace the dried buttermilk, thus cheapening the ration. Skim milk is excellent for ducklings; it can be used to moisten the mash, but do not give it in the form of a drink. If there is ample milk available, allow it to curd and strain off the whey, then feed the curds. Imitate nature as far as possible by giving several small meals daily to young ducklings. A little and often is a good motto to adopt. After four weeks of age, they may be fed on a similar ration to the mature ducks. When mature it is only necessary to give them three meals daily, supplying as much food as the ducklings can consume in about half an hour. Be sure they have a big evening meal.

A ration that will give excellent results for the feeding of mature ducks is comprised of the following ingredients: Pollard, 55 lb.; bran, 25 lb.; maizemeal, 10 lb.; meatmeal, 10 lb., bonemeal, 1 lb.; and fine salt, 1 lb.; to which may be added 25 per cent. of cooked vegetables or chaffed green stuff. The salt should be mixed in the liquid first, so as to ensure a thorough incorporation in the mixture. At least two meals should be given daily, but with mature birds a small meal of whole maize may be fed in addition to the mash.

For the fattening of ducks consideration must be given to the availability of cheap foodstuffs, which are often obtainable in the form of potatoes, pumpkins, and other vegetables; these should be boiled and may be added to the mash upwards to 40 per cent. of the bulk. Chaffed green stuff should be included, but do not use much green stuff when making use of a large proportion to other cheap foodstuffs, otherwise the mash may be too bulky.

Always keep a supply of shell grit and coarse sand in receptacles before the birds.

WATER

Water is one of the biggest factors in successful duck-keeping; they must always have access to ample, clean, cool fresh drinking water. The water vessels or pool should be sufficiently deep to permit the ducks to

submerge their heads. The water vessel should be kept under a shade tree or protected from the sun by providing artificial shade. In rearing ducklings it is a good plan to put a number of stones in the water vessels; this prevents the ducklings swimming and wasting the water.

Water vessels should be constructed so the ducklings can get out easily in the event of their swimming in the vessels, otherwise they may drown through cramp. This cramping is more likely to occur during cold weather.

COMMON TROUBLES

As stated previously, ducklings are hardy and easily reared, but losses will occur if they are neglected. The most common troubles are chills and staggers.

Chills.—Symptoms—Watery eyes and nostrils. Cause—Wet or damp sleeping quarters.

Remedy.—Keeping the floors dry is the most important point. The drinking water may be slightly coloured with permanganate of potash, and changed several times daily.

Staggers.—Symptoms—Ducklings stagger about and fall on their backs before dying. Cause—Lack of water. When water is supplied after there has been a shortage, the ducklings gorge themselves, bringing about this condition.

Remedy.—Keep a constant supply of drinking water before the ducklings.

MINUTES OF THE MEETING OF THE CENTRAL BOARD OF AGRICULTURE

THE third meeting of the Central Board of Agriculture was held in the Board Room of the Department of Agriculture, Peradeniya, at 2 p.m. on Thursday, January 10th, 1935.

Dr. W. Youngman (Director of Agriculture) presided, and the following members were present: Messrs. G. Robert de Zoysa, M.S.C., E. C. Villers, M.S.C., M. Crawford (Government Veterinary Surgeon), B. M. Selwyn (Chairman, Planters' Association of Ceylon), James Forbes (Jnr.) (Chairman, Tea Research Board), Dr. R. V. Norris (Director, Tea Research Institute), Messrs. T. E. H. O' Brien (Director of Research, Rubber Research Scheme), F. P. Jepson (Controller of Plant Pests), M. Park (Mycologist), Dr. A. W. R. Joachim (Agricultural Chemist), Dr. J. C. Haigh (Economic Botanist), Mudaliyars S. Muttutamby and N. Wickremaratne, Messrs. C. Arulambalam, F. C. Charnaud, R. G. Coombe, Wace de Niese, L. W. A. de Soysa, H. D. Ditmas, J. W. Ferguson, G. Bruce Foote, R. P. Gaddum, M. Jayawickreme, E. E. Megget, Graham Panditteseker, Wilmot A. Perera, Rolf Smerdon, U. B. Unamboowe, Rev. Father L. W. Wickremasinghe, Messrs. C. Huntley Wilkinson, and W. C. Lester-Smith (Secretary).

Visitor: Mr. S. J. F. Dias.

Intimation of inability to attend the meeting was received from the Hon'ble Mr. F. A. Obeyesekere, M.S.C., the Hon'ble Mr. C. W. W. Kannangara, M.S.C., Mr. E. H. Lucette (Register, Co-operative Societies), Mr. J. S. Kennedy (Acting Director of Irrigation), Dr. R. Child (Director of Research, Coconut Research Scheme), Messrs. S. Armstrong, L. G. Byatt, John Horsfall, S. M. K. Madukande, Dissawe, and Mr. Gordon Pyper.

CONFIRMATION OF MINUTES

The Chairman indicated that the minutes of the second meeting held on September 13th, 1934, and of the continued session held on November 8th, 1934, had both been circulated, the latter only very recently. He hoped that all members of the Board had received their copies of the minutes and asked whether all present were in favour of their confirmation.

Mr. Bruce Foote stated that before the minutes were adopted he would like an alteration made in the minutes of the second meeting held on September 13th. He indicated that in the second paragraph on page 6 he was represented as having said that "grass did not grow under rubber" He said that to the best of his recollection what he had said was that "grass did not grow to be a menace under good rubber."

The minutes were then confirmed, subject to the above alteration.

THE DISPOSAL OF THE FUNDS OF THE PREVIOUS BOARD OF AGRICULTURE

The Chairman informed the meeting that the Executive Committee of the Central Board of Agriculture had considered this matter very carefully at its last meeting and had decided to recommend to the Central Board of Agriculture that the proposal of Mr. Rolf Smerdon at the second meeting of the Central Board be adopted, save that the funds be at the disposal of the Executive Committee of the Central Board of Agriculture instead of the Director of Agriculture. It was considered that this recommendation fulfilled the object of the original grant and the Executive Committee also advised the Central Board to ask for the transfer of the funds to the name of the Executive Committee of the Central Board of Agriculture at the next renewal of the fixed deposit. After careful consideration, the Executive Committee had decided that this was the best advice that they could give to the Central Board.

Mr. Rolf Smerdon pointed out that they should appreciate the position of their Chairman in this matter in that he was not able to hold these funds; the resolution as amended by the Executive Committee fully expressed what he had intended by his original proposal. With the permission of the seconder he would amend his previous proposal "that the money be handed over to the Department of Agriculture for distribution to exhibitions to be held in various parts of the country." He then proposed:—

> "That the funds handed over to the Board of Agriculture by the Executive Committee of the All-Ceylon Exhibition Fund be transferred to the name of the Executive Committee of the Central Board of Agriculture at the next renewal of the fixed deposit."

Mudaliyar N. Wickremaratne agreed to the amendment and seconded it.

In reply to a query by Mr. Wace de Niese, Mr. Rolf Smerdon stated that these funds were to be used to foster agricultural and horticultural shows in the Island, and he pointed out that this was also expressly stipulated by the Executive Committee of the All-Ceylon Exhibition Fund when the money was handed over to the Board of Agriculture.

The Chairman, in reply to further queries, explained that the Executive Committee of the Central Board of Agriculture went into this matter very fully and decided to advise the Board to accept the resolution of Mr. Rolf Smerdon with the substitution of the words "that the funds be at the disposal of the Executive Committee" instead of the Director of Agriculture as was originally suggested. The Executive Committee had considered that this met the purpose for which the funds were originally intended. At a meeting held on April 21st, 1913, the Executive Committee of the All-Ceylon Exhibition Fund resolved that the balance in hand be handed over to the Board of Agriculture with a copy of the statement of accounts and of the recommendation that the Government Grant of Rs. 15,000/- be refunded to Government and the remainder of the balance, some nine thousand rupees odd, be placed on fixed deposit to be utilised towards financing similar exhibitions in the future. The Executive Committee

of the Central Board of Agriculture considered that the allocation of this money towards exhibitions in the Island would be meeting the purpose for which it was originally intended.

Mr. Wace de Niese stated that in view of this explanation he supported the resolution and suggested that in view of the fact that the Ministry of Labour, Industry and Commerce contemplated holding an industrial Exhibition this year, it would be well if they could have an agri-horticultural exhibition in conjunction with it.

The Chairman then put the resolution of Mr. Rolf Smerdon to the meeting and it was carried unanimously.

ANIMAL HUSBANDRY IN CEYLON

The Chairman called upon Mr. Crawford to read his paper on the subject of animal husbandry in Ceylon.

Mr. Crawford said that there was, without doubt, a general tendency in Ceylon to consider animal husbandry as of minor importance in the agricultural economy of the Island. In a large degree this was probably due to attention being focussed on the four great major crops of Ceylon, namely, tea, rubber, coconut and paddy. There was a tendency to lose sight of the fact that animals do play a part in the production of even the major products. He would endeavour to show that livestock, even under present conditions, were of importance to all agriculturists, no matter in what crop they were chiefly interested. He said he would also attempt to show that it was possible, and with advantage, for livestock to play a more important part. First of all he desired to give them some idea of the economic importance of livestock and their products at the present time, but one immediately encountered the initial difficulty of the absence of reliable statistics. In the case of major agricultural products it was easy to obtain figures, the areas devoted to their cultivation were tabulated, market prices were quoted daily, estimates of production made from time to time and export figures frequently published. In the case of livestock he said such figures were largely lacking, but the following figures would serve the purpose of showing that livestock and their products had a greater value in the aggregate than was generally realised.

He stated that at a reasonable valuation, the capital value of Ceylon's livestock might be estimated as follows:

		Value
1,000,000 Neat cattle at Rs. 10/- each	...	Rs. 10,000,000
500,000 Buffaloes at Rs. 25/- each	...	,, 12,500,000
250,000 Sheep and Goats at Rs. 5/- each	..	,, 1,250,000
45,000 Pigs at Rs. 10/- each	...	,, 450,000
	Total	Rs. 24,200,000

There were no figures for poultry but they were found in every village and must number several millions. The total livestock therefore represented a capital value of about 20 million rupees. It was even more difficult to arrive at an estimate of the value of the livestock and their products

which were utilised annually; there was actually an annual export which consisted chiefly of hides, skins and leather, and meat was supplied to ships calling at Colombo. In a normal year, such as 1929, the value of these exports approximated Rs. 2,000,000 but had fallen greatly in recent years as a result of the slump in prices. The value of hides would be much greater if they were free from brandmarks; he had been informed that they would fetch almost three times their present value were this the case. The value of livestock exports in 1929, he said, was nearly equal to that of the plumbago exported, and was greater than the value of such products as cardamoms, citronella, papain, timber, or tobacco. The value of cattle, buffaloes, sheep and goats slaughtered for meat in 1932 was more than Rs. 2,000,000. There were no statistics for the quantity of milk produced and sold locally, but it had recently been estimated that about 6,000 gallons of milk were sold daily in Colombo. If this figure were accurate, it represented a sum of Rs. 4,000,000 per annum for Colombo alone. There were no figures for eggs and poultry sold locally but a slight indication of the value of the table poultry produced could be gathered from the fact that in 1929 the imports were valued at over three lakhs of rupees and although such imports had been prohibited in the past few years, on account of the introduction of disease, the local supply had proved fully capable of meeting the demand without any increase in price. These few figures would help to give some idea of local production, the greater part of which was village produce but in spite of the very considerable local production, it was still necessary to import such livestock products as tinned milk, butter, cheese, eggs and bacon, the total annual value of which was about Rs. 2,050,000. It was satisfactory to note, he said, that there had been a marked decline in the import of eggs during the last few years; from a total of 15,000,000 eggs valued at Rs. 500,000 in 1929, to 7,000,000 valued at just over Rs. 200,000 in 1933. The figures for 1934 would probably be less on account of the increased duty. These figures indicated that local production represented a large annual cash turnover and further that there was still margin for increased local production.

Mr. Crawford then went on to outline the part played by animal husbandry in the agricultural economy of Ceylon and its value in the nutrition of the population. He pointed out that for the purpose of paddy cultivation cattle and buffaloes were a vital necessity. It was surprising to what a small extent cattle manure was used for paddy cultivation; cattle and buffaloes were found in almost all paddy growing areas, yet, with the exception of the Jaffna district the dung was rarely collected for purposes of manuring. There was a simple method of preparing pen-manure in which weeds, hedge loppings, etc. were collected during the day and spread in a layer on the floor of a pit into which cattle were driven for the night. They trampled the vegetable material and it became mixed with their dung and urine, and in this way considerable quantities of valuable manure could be prepared at a low cost. He considered that the general adoption of this practice by paddy cultivators would assist in increasing the yield of paddy, the lowness of which was so frequently deplored in Ceylon.

In the coconut industry cattle played a much more important part than they did in the case of tea and rubber, especially for transport, purposes of cultivation, and manuring, which in the case of coconuts was usual by tethering the animals round the palms. For purposes of utilising the manure and of adding material in bulk, better results were obtainable from the use of pen-manure. He considered that coconut estates would benefit considerably by combining animal husbandry with coconut production to a much greater extent than was done at present. On several estates he had seen poultry farming practised with a considerable measure of success. Poultry manure appeared to be one of the best manures for coconuts, and sheep and goat manure were also of great value, as he had seen on several estates. The present low price of coconuts made it difficult for the planter to purchase artificial manures, so that the possibilities of cattle, goat and poultry manure were worthy of consideration.

In the case of tea estates, livestock now played a small part compared with some years ago, when, prior to the development of motor lorry transport, all the carting was done by bullock carts and most estates had large cattle sheds for housing their bulls. The manure produced was a valuable asset to the estate. He said he did not consider himself competent to express an opinion on the manuring of tea, but he understood that lack of humus was one of the commonest defects of tea soils; might it not be that the supplies of cattle manure available in the days of bullock carting were of much greater value than the expensive artificials now used, especially from the viewpoint of maintaining the humus content of the soil? Was it not possible, he asked, that cattle manure could be advantageously used more extensively than it was at present? In conjunction with the growing of tea was found a very specialised and very valuable section of the livestock of Ceylon, namely the breeding of good milking cows of European and Australian breeds. These cows, descendants of cattle imported by the old time proprietary planters, were to be found on almost all up-country tea estates; usually in the hands of kanganies and labourers. Today they were practically the sole source of the supply of cows to town dairymen and without them dairying in Colombo and other large towns would be in a very difficult position. Unfortunately these cattle were showing signs of deterioration largely due to lack of importations of fresh blood and partly to unsuitable methods of housing and management. Unless fresh blood were introduced in the near future, the standard of these cattle in the up-country districts would deteriorate greatly, and already dairymen in Colombo were finding it difficult to get cows of the standard they did a few years ago. It would be a serious matter if the deterioration already beginning increased and it would make the milk supply in the larger towns even more difficult than it was at present. In the past it appeared to have been quite a common practice for proprietary planters to import cattle from Great Britain or Australia, but unfortunately this was not the case now and for some years past not a single bull or cow had been imported, other than one or two for the Government Dairy in Colombo. He believed he was correct, he said, in stating that the late Mr. A. A. Bowie, of Great Western Estate, Talawakelle, was the last to import

cattle for use up-country, and this was some years before his death. Freight charges on cattle were now so heavy that it was hardly to be expected that up-country planters would import cattle in the future. In some countries, such as Rhodesia and Kenya, schemes for assisting importers of pedigree cattle were in existence and it would appear that unless some such scheme were introduced in Ceylon, a very valuable section of the cattle would show a progressive deterioration. He had recently had enquiries from a few people who desired to import pedigree cattle but they found that the high freight charges were more than they could afford. These enquiries, he said, indicated an interest in good milking cattle which one would wish to encourage, but at present there was no scheme in Ceylon to assist in this matter.

It had often occurred to him that given suitable methods of transport, a large part of the milk supplies of the towns could be produced on tea estates more cheaply than by the present town dairies. Distances in Ceylon were not great, railways and roads were available, and modern methods of handling milk made it possible to transport it with safety. Attempts were being made in Colombo to establish a central organisation for collecting and distributing milk. When this organisation had developed, tea planters should consider carefully whether it would not be to their benefit to establish herds of milk cows and send the milk to Colombo. They had the advantage that cows of European and Australian good milking breeds could be bred up-country; such cattle could not be bred economically in the town dairies. The manure produced would benefit the tea and reduce the bill for the cost of artificial manures.

In the rubber industry cattle played an even less important part, practically their only use being for transport, and that to a lesser extent than formerly. Cattle manure was seldom or never used on rubber estates, presumably not because it was unsuitable for rubber but because on most estates it was not available.

From what he had said, he thought it would be clear that cattle were absolutely indispensable in paddy cultivation, played an important part in coconut production, and to a much lesser extent were a useful adjunct to tea and rubber cultivation. In village economy, cattle, goats, poultry, eggs, and in some places ghee, were a useful means of raising ready cash; cattle, to some extent, from what might be regarded as an emergency bank to which resort could be made in times of difficulty.

Mr. Crawford then turned to another aspect of the subject, that of the importance of animal products in the nutrition of the people. He said that, as all were aware, the diet of the greater part of the population of Ceylon was largely vegetarian, consisting of cereals, such as rice or kurukkan, vegetables, condiments and a little dried or salted fish. Evidence had accumulated from all parts of the world, of the great importance in the diet, especially of infants and young children, of such foodstuffs as milk, ghee, eggs and meat. Dr. Nicholls, Director of the Bacteriological Institute, in a lecture delivered some little time ago, had drawn attention to the fact that unmistakable evidences of malnutrition were present in a large proportion of school-going children in

Ceylon, particularly those of the poorer classes. He had shown that many of the defects present were those associated with a deficiency of vitamins A and D, the richest sources of which were milk, eggs, liver and animal fats.

The infant and child mortality figures for Ceylon were unduly high as compared with many other countries and they strengthened the contention of Dr. Nicholls that the nutrition of children in Ceylon was not satisfactory. In his lecture Dr. Nicholls had indicated that the remedy was the greater use of milk, ghee, eggs, animal fats, etc., but was rather pessimistic as to whether the poorer classes in Ceylon could afford to purchase these foodstuffs. One had little hesitation in saying, Mr. Crawford continued, that as far as the rural population were concerned, the villager could supply his own needs with very little expense provided the desire to do so existed. Cattle were numerous in nearly all Ceylon villages, yet it was exceptional to see a cow being milked. A common reason given for this was that the Ceylon cow gave so little milk that it was not worth milking. Mr. Crawford said he could not accept this explanation; it was true that the village cow was too low a milk yielder to be of use to the dairyman, but most of them would give two or three pints if given some extra feeding and many would give up to four, five or six pints which would be a sufficient quantity for most families.

Further, poultry and goats could be reared easily in the villages with very little expense, and enough hens to supply the needs of the average family in respect of eggs and chickens could be kept for practically nothing by most villagers. Apparently the reason why so little foodstuff of animal origin was used was based on the religious beliefs of the great majority of the inhabitants. This probably explained the small consumption of eggs, chickens, meat and mutton, but it did not explain why milk and ghee were so little used. Perhaps by means of propaganda in the schools it might be possible to educate the rural population as to the value of milk and ghee, with a consequent improvement in health and physique, and incidentally an increased interest in their livestock.

Before concluding, Mr. Crawford indicated that his remarks had been designed to bring to notice some facts which were not generally realised. Those interested, he said, would find the subject more fully dealt with in Sessional Paper XXVII of 1933. In conclusion he summarised the position as follows:

(a) That livestock were of greater importance in Ceylon than was usually realised and they merited greater attention than they had received in the past.

(b) That so far as cattle were concerned, there were large numbers but they were not being utilised to the fullest advantage; particularly as regards the use of the manure as a fertiliser.

(c) There were good reasons for believing that the health and physique of the people in Ceylon would be benefited by the more general use of such foodstuffs as milk, ghee, butter, eggs, meat and mutton.

(d) As the use for food of such things as eggs, meat and mutton was contrary to the religious beliefs of a large proportion of the population, any great increase in their consumption could not be anticipated. On the other hand there was no reason why the consumption of milk, ghee and butter should not be greatly increased. If this were to take place local production would require to be greatly stimulated, as even at the present low level of consumption it was necessary to import these foodstuffs.

Mr. Rolf Smerdon indicated that he considered Mr. Crawford had answered his own question as to why milk and ghee were not made use of, by what he had said at the second meeting, which was that to catch or handle Ceylon cattle was practically impossible in many cases.

Referring to Sessional Paper XXVII of 1933, Mr. Rolf Smerdon stated that through the courtesy of Mr. Crawford he happened to have a copy. It was one of four copies but he did not know if it were one of the only four copies printed. He asked the Chairman if he had received a resolution from the Kegalle District Agricultural Committee on this subject: that more copies should be made available.

The Chairman stated that this resolution had been received from Kegalle and that application had been made to the proper quarter but this paper was out of print. There appeared to have been a very small number printed and they had been unable to obtain any more although they had applied for them.

Mr. Rolf Smerdon said he would like to implement the resolution of the Kegalle Committee and move that the Central Board do urge the Ministry that this most interesting and well written paper be reprinted.

Mr. Bruce Foote seconded this proposal with the addition that copies of the paper be circulated to all members of the Board when printed. These proposals being acceptable and the meeting being in favour, it was carried unanimously:

> "That the Central Board of Agriculture do urge the Ministry of Agriculture and Lands that Sessional Paper XXVII of 1933 be reprinted; and do request when printed, that copies be circulated to all members of the Central Board of Agriculture."

The Chairman then stressed the very great importance of milk in the diet of the people of Ceylon which, he said, had been fully recognised by the medical profession. The important fact was that milk contained the element calcium, which he considered as more lacking than vitamins in the food of the people; milk was practically the best source of calcium for children. During the present epidemic of malaria he had encountered an aversion to the consumption of milk even when it was supplied free and he thought that there must be religious grounds for it; perhaps one of the Buddhist members present would tell them something about it.

Mr. J. W. Ferguson said he did not think they had that difficulty on estates; he found that estate labourers would take any quantity of milk if it were given to them free, but that they would not purchase it,

They kept cattle but they would not even give the milk to their own children but sold it to the caddies; it had to be bought to be given to the children. He considered that the Tamil labourer worked his cattle very well indeed and he quoted the particular instance of one, a watcher, who had educated his two sons at Ramanathan College, Jaffna, on the proceeds of one cow. He considered that on estates the labourers did make a profit from cows, but recently the demand in Colombo appeared to have gone down with the result that many labourers had given up keeping cows.

Mr. Bruce Foote added that on an estate of which he had charge during the rubber slump, a number of labourers to whom he could not give work refused to leave the estate; they were quite willing to live in the lines and keep their cattle and sell the milk. Now that times were better he was anxious to take these labourers back for work but they still preferred to live in the lines doing no work, receiving no pay and selling their milk in Avisawella.

Mr. G. Robert de Zoysa stated that there was no belief among Buddhists which constituted an objection to the drinking of milk. On the other hand he thought that there was an insufficient quantity available and that the Department were not doing enough to improve the breed of animal and so provide for an adequate milk supply; if that were done he considered there would be a greater consumption of milk.

Mr. Wace de Niese said he believed that the prejudice against the drinking of milk lay more in the belief that it was injurious to a cold or when one had symptoms of fever. Villagers avoided drinking milk when they had these symptoms; it might be a prejudice but he had noticed during the past fortnight that even children were not given milk when they were ill.

Mr. Graham Panditteseker stated that the trouble in the Chilaw district as regards milk was that there was not enough pasture available on which to feed the cattle. Planters had recently taken to the growing of green cover crops on their estates and had found cattle to thrive on them. There were, however, two schools of thought on the growing of cover crops under coconuts, and if it could be determined whether green cover crops were good for the coconuts, cattle could be kept at a profit. They could not expect Government to give them more land for pasturage because all the land was planted.

Mr. Wilmot A. Perera agreed with the previous speaker that the main difficulty was pasture and not any disclination to drink milk. Where Buddhist sentiment came in was in imposing limitations on animal husbandry and the improvement of cattle because they would not do away with useless animals. He considered that the position would be considerably eased if there were some system, as existed in India, of driving old and useless cattle into stalls where they were maintained at the expense of the State.

The Chairman intimated that nearly all of the cattle would have to be so treated. He was pleased to hear the remarks that had been made but he did consider that the Board could do something by impartially

ascertaining what was the prejudice regarding the consumption of milk. He was quite willing to admit, he said, that the dearth of pasture land in the villages had been a very serious problem in the past, Mr. Crawford and he had had their attention drawn to the position of cattle and milk production and he was almost certain that there was some prejudice behind it all that required to be carefully and impartially examined. He quoted from his own experience the case of two Sinhalese families to whom free milk was offered and refused while they accepted and used offers of proprietary milk, one of which came out of a bottle and the other a tin. There appeared to be some objection to consuming fresh milk but much less or no objection to some form of condensed or malted milk. He indicated that there was no question in this case of the scarcity of pasture or of poor cows and he thought that quite apart from sentiment or politics the whole question of milk consumption in the Island required to be seriously examined. He considered that they should try to find out what was the prejudice, as in that way there might be the means of improving the health of the children. As Mr. Crawford had said, Dr. Nicholls was of the opinion this could be done if the consumption of dairy products in the daily diet could be increased. He had noticed the same thing in the villages, he said, it was not the absence of milk, though there might be a scarcity, but even where milk was obtainable there was a total disinclination on the part of the people to use it in their daily diet. He was unable to find the reason for that himself and he thought some members might be able to throw some light on this point.

Mr. G. Robert de Zoysa said that the wide-spread prejudice among the population against the use of cow's milk in its natural state might be due to its unfavourable comparison with the intensively advertised proprietary brands of milk foods.

Mr. Crawford said that the prejudice against the use of milk was undoubtedly peculiar to Ceylon. He had often enquired in the villages why milk was not used and the general reply was that the quantity obtainable was so small as not to be worth the trouble of milking. On other occasions he had been told that the children were not given milk because it caused worms. This prejudice was probably due to a wrong diagnosis of the cause, as worms in children were usually associated with intestinal troubles caused by the use of dirty utensils which made the milk unwholesome .He considereed that was why tinned milk was used in preference to fresh milk; for people did not realise how quickly milk goes bad and also the importance of sterilising the vessels and keeping them clean. He was of the opinion that the problem was one which the schools should take in hand; through the schools it would be possible to eradicate this prejudice. The Medical Department might obtain the necessary literature and disseminate it through the agency of schools. In this connection he thought a demonstration in some of the schools might be of value. In England, Scotland, many parts of Europe and America, large-scale experiments had been carried out in schools. The one that impressed him most was where, out of ten thousand school children five thousand were given a pint of milk free daily, while the other five thousand received no milk. These children had been carefully

weighed and measured over a period of a year, and the results at the end of the period proved beyond doubt the great benefit to the children who had received milk. These were not poverty-stricken children either, but children who received a good diet. If such children could benefit from milk, the results in Ceylon should be more striking. He considered that if the Medical Department could arrange with a school and repeat the experiment on a small scale in Ceylon, it would do a great deal to remove the prejudice against the use of milk.

Mr. C. Arulambalam suggested that in view of the lack of pasture in Jaffna, drought-resisting grasses which would do well in dry areas should be experimented with at the Tinnevelly Experiment Station. He had obtained roots of Kikuyu grass from the Experiment Station, Peradeniya, and they had rooted well, but it was too early yet to say whether this grass would do well in that zone.

Mr. R. G. Coombe then enquired whether the Chairman could give them some indication as to what acreage the Department had put under grass in the various agricultural stations in the Island during the past six to nine months.

The Chairman said he could not state the exact acreage, but that during the past two years it had been the desire of the Ministry of Agriculture to encourage the growth of fodder and pasture grasses and much work had been done. Enormous quantities of planting material had been supplied from the Experiment Station, Peradeniya and other places, and almost all experiment stations had plots of fodder grasses, and in many cases pasture grasses also. Attempts had been made to improve the pasture areas on the Experiment Station, where special emphasis had been laid on pasture rather than fodder grasses; between thirty and fifty varieties were being tested and the possibilities of indigenous grasses examined. There were also many introduced grasses being tried, such as Kikuyu grass which had only been under experimentation for a short time. This grass originally came from Africa, being named after the Kikuyu tribe. It had been introduced into Australia where there were now millions of acres of it, as well as of *Paspalum dilatatum*, so much so that one heard of references to the Kikuyu tract or the Paspalum tract.

There was one point, he continued, which he thought should be very clearly kept in mind. At the last meeting, in the discussion about cotton cultivation, Mr. Wilmot Perera had mentioned a point which had struck him as extremely important and which he was pleased to hear coming from him. That was that sentiment should be eliminated from this matter. Ever since he had been in the Island he had heard a lot about pasturage, seventy-five per cent. of which was sentiment and twenty-five per cent. utility. A most important matter such as the provision of pasturage must not be allowed to become a political catchword. The provision of pasturage was absolutely necessary; the Agricultural Department knew and admitted it, but as soon as there was any talk of "why has not something been done to improve cattle" immediately the question of pasturage was raised. Pasturage was very important indeed,

but if the improvement of village pasturage was desired, the village itself must enter into it and do certain things communally. Unless this was done sentiment entered into it and the phrase "the provision of pasturage" became merely a political catchword, as he was sure it had become in many cases, and then no progress at all would be made. He said this because he was perfectly certain it was a warning that was required. It had to be remembered that a certain amount of sacrifice on the part of the villager was essential. He had to be prepared to fence areas, to keep cattle off certain areas and rest them while the experiment was being tried and to give some assistance communally in connection with the labour required to fence the area and see that neither he nor his neighbours encroached upon it and put their cattle on the portions that it was decided should be left to rest for one or two years. So far as the Agricultural Department was concerned—the Veterinary Department was also doing its part—they were doing everything they could and were doing more and more every day in connection with this subject of pasture. They had no large stock of Kikuyu grass at present; they had had to import what they had from Australia and as the supply increased it was being distributed to different parts of the Island. It had not yet reached Jaffna itself, but was very nearly there, an area being under experimentation at Paranthan from where he hoped shortly to be able to supply cuttings to Jaffna. He wished to stress the fact that the subject of pasture and fodder were very much in the mind of the Minister and of the Department of Agriculture, and that if it could be approached in the village without politics and without sentiment, but in real earnest, he considered a great deal could be done.

Mr. R. G. Coombe said he was very much obliged to the Chairman for his remarks and he would like to say straightaway that he no longer dabbled in politics. He thought it would be useful to the Board if they could be given at intervals some indication of what was being done, bearing in mind the most interesting progress reports they used to have in the past. He said that he considered in a matter like this, in which the whole of the indigenous population were concerned, the increase of pasture and fodder should engage the attention of every member of the Board. With reference to these grass trials and demonstrations in various centres he would like to ask the Chairman a very frank question. Was he satisfied that real progress had been made by the demonstrations and the work done by his Department, or had the work done so far not been as successful as he would wish it to be? He was entirely in sympathy with Mr. Crawford in the matter he had brought forward, he said, but he could not help feeling that they were putting the cart before the horse. It was no good increasing the number of cattle until they had the fodder on which to feed them and until they had a very large area of grass and fodder throughout the Island, especially in the Dry Zone. He thought it was up to the Board to foster the increase of fodder grasses in every direction possible and he hoped that at intervals they would be informed of the progress made or difficulties experienced, so that if necessary they could give any assistance that lay in their power in this matter.

Mr. Graham Panditteseker e said that if it would be possible to grow some indigenous grasses under coconuts in the Chilaw district, he would like to make a start.

The Chairman said that both in the low-country and up-country it was possible to grow indigenous grasses and that such were on trial at the present time. With regard to the suggestion of Mr. Coombe that the Board should be kept informed of the progress of pasture and fodder grasses, he thought it was a wise one which could be acted upon. As regards his question, so far as he was concerned, and the Department generally, they were never satisfied with the progress they made in connection with anything. Whenever they made progress, they always wanted to make more progress; they were a very difficult Department to satisfy with anything of that kind. But progress had been made, he said, and even in that part of the country from which Mr. Coombe came there were experiments going on on the patna hillsides.

After further discussion, to which Messrs. G. Robert de Zoysa, Wace de Niese, Graham Panditteseker e, C. Huntley Wilkinson, G. Bruce Foote, Rolf Smerdon, Mr. Crawford and the Chairman contributed, Mr. Rolf Smerdon proposed:

> "That the Central Board of Agriculture do suggest to the Ministry of Education and the Ministry of Health that an experiment should be designed to feed a certain number of children in certain areas as a matter of educational value in the consumption of milk, on the lines suggested by Mr. Crawford in the discussion on his paper."

Mr. G. Robert de Zoysa seconded and the motion was carried unanimously.

The Chairman undertook to see that this resolution was forwarded to the Ministries concerned.

Mr. R. G. Coombe asked the Board to express its warm appreciation to Mr. Crawford for his paper. It had given them something to think about and he thought it should be carefully studied.

The Chairman said he was sure they were all indebted to Mr. Crawford for his interesting paper.

AGRICULTURAL DEVELOPMENT THROUGH SCIENTIFICALLY PLANNED REGIONAL SURVEYS WITH DEFINITE OBJECTIVES

The Chairman intimated that Mr. Wilmot A. Perera had requested that this item regarding agricultural development be placed on the agenda. Mr. Wilmot Perera had also been authorised by the Chairman of the Kalutara District Agricultural Committee, of which Committee he was a member, to bring up a closely connected proposal. The Chairman suggested that as these motions were connected, the best plan would be for Mr. Wilmot Perera to first move his own resolution and afterwards that of the Kalutara District Agricultural Committee.

In this connection he wished to make clear the method of putting up resolutions to the Central Board, about which there appeared to be some misconception. He indicated that the normal method of bringing up a motion before the Central Board was for a member of the Board to bring up a resolution on the subject concerned for consideration and discussion. He considered that they should keep to the accepted way of bringing up motions as all District Agricultural Committees had one and in some cases two representatives on the Board to bring up matters before the Central Board, or to move a definite proposal. He then called upon Mr. Wilmot Perera to speak on the resolution he wished to bring up for their consideration.

Mr. Wilmot A. Perera said he wished to move:

> "That this Board is of the opinion that the agricultural interests of the country can be best served only by scientifically planning out its development through regional surveys with definite objectives in view."

He would like to state, he said, that in this instance he was more concerned with peasant agriculture than with the three main agricultural industries. There was one point that had always to be kept in mind; this was that 86·8 per cent. of the population of this country lived in the villages and if the welfare of the country were to be promoted, it must affect their lives, and particularly their everyday life which was dependent upon the productivity of their land. For this reason, he said, this was a matter of the greatest national importance because the prosperity of this country depended upon the prosperity of their agriculture and its development on well-thought-out scientific lines. What, he asked, did they find today regarding the development of their agriculture ? A large number of schemes of doubtful utility, a great deal of unscientific thought and no planning whatsoever. He said they could not afford to carry on as they had been doing, the risk was too great and the price was too heavy. Conditions were not what they were a few decades ago. No economic policy could remain constant; its application must change with changing conditions. Their immediate aim must be to establish a planned system of agricultural production and distribution which could steadily improve the living conditions of the people. For this purpose a system of regional surveys was required which would take into consideration all the factors affecting the agriculture of the area; such factors as land, its availability and fertility, agricultural pursuits best suited to it, irrigation problems affecting it, present and potential production; in fact everything relating to the most economic use of the land in its relation to national economy.

What was happening in the country today, he continued, was that schemes for its agricultural development, or rather a problematical development, were constantly being brought before the Legislature, the acceptance of which depended more upon the forcefulness of the personality of its advocates than on the intrinsic merits of the proposals themselves. Someone got a road, another a drain, and still another a bridge. There was very little co-ordination, no integration of policy and no planning

ahead. The only proposal for anything approaching a planned development, so far as he was aware, was the suggestion of Mr. S. W. R. D. Bandaranaike for a five-year plan for Minneriya when this matter came up in the State Council; unfortunately any mention of a single word associated with the Russian experiment appeared "to send people off the deep end" in this country.

The only opportunity available at present for the public to obtain a general view of the intentions of the Government and of their effect was the annual budget; but the form in which it was presented today conveyed little more than a view of the national revenue and expenditure. Although there were opportunities for criticising each piece of legislation as it was brought forward, there were little or no opportunities of varying the order or the substance of what was proposed. There was no statement of the policy that was necessarily contained in the financial provisions. What was required was to obtain a view of the proposals for the agricultural development of the country as a whole.

The machinery to give effect to his proposals, he said, was already in existence in this very Board, based as it was; and, in conjunction with the Economic Advisory Council recommended by the Banking Commission in its recent report, it could do a great deal to survey and formulate proposals for developing national economy as a whole. The obtaining of the regional surveys which he had envisaged must precede any such development; the details of the co-ordination, etc., required, he did not propose to go into them as they would come within the purview of the subsequent proposal.

He was sure, he said, that the Director of Agriculture and his officers would welcome the acceptance by Government of his suggestion, in that the Department would know exactly what problems they had to tackle for the development of the countryside and the direction of the research work expected of them.

Mr. C. Arulambalam seconded the resolution. He said he thought that the experiment stations were intended to ascertain what particular products were suited to the areas in which they were situated. He thought that such experiment stations, if properly developed, would form a suitable means of solving the problem.

Discussion on this resolution was deferred for consideration with the next and inter-related motion being proposed by Mr. Wilmot A. Perera on behalf of the Kalutara District Agricultural Committee.

ESTABLISHMENT OF A BUREAU OF AGRICULTURAL ECONOMICS TO COLLECT STATISTICS UPON WHICH SURVEYS MAY BE BASED

Mr. Wilmot A. Perera intimated that he had been deputed to move the following resolution passed by the Kalutara District Agricultural Committee:

> "That this Committee would wish to bring to the notice of the Central Board of Agriculture the extreme desirability of setting up a bureau of agricultural economics as a branch of the Department of Agriculture to collect statistics relating to rural problems and prepare surveys based theron."

He said he would like to trace the history of this resolution and asked to be excused that the personal factor intruded so much. The resolution, he said, had been accepted at his instance. Some time early in 1932 he prepared a paper which had been read before the Raigam Korale Rural Reconstruction Society Conference. In this paper he had referred to the need for a rural economic survey; he had set out to collect statistics regarding paddy cultivation and was bewildered by the lack of reliable statistics regarding paddy or anything else relating to village agriculture. In February, 1934, at a meeting of the General Committee of the Central Society, the resolution in a slightly amended form was sent to the Ministry of Agriculture and to the Ministry of Labour and they had asked for a small sum of money to defray the cost of printing some statistics they wished to publish, but beyond the usual acknowledgement nothing had happened. In his paper he had stated that hungry and indigent people could think of little else but of maintaining life or of the next meal. The next day a correspondent to the Press had written that all talk about the poverty of the peasant was absolute nonsense. He hoped, he said, that the present malaria epidemic had taught that correspondent and those who thought with him, the real state of the peasantry of this country.

Mr. Wilmot A. Perera then quoted from his booklet ("A Socio-Economic Survey of the Raigam Korale") with regard to the need for statistical studies relating to economic conditions; and also from the Report of the Royal Commission on Agriculture in India with regard to the "influence for good which Universities can exercise over rural development" and their obligation to use that influence "in regard to such technical matters as economic surveys of social conditions." So far, he said, such statistics were non-existent in this country. Some time ago Mr. Bagot had brought up a resolution at a meeting of the Nuwara Eliya District Planters' Association regarding the preparation of indices of the cost of living, but he had heard nothing more about it. There appeared to be no information of any sort available in Ceylon to the student of economics.

Regarding the subject of agricultural economics, he said that the technique of rural sociology had been developed best in America. President Roosevelt's Commission on Country Life in 1907 and its report submitted four years later awakened the national mind to the importance of the subject. Today it occupied a prominent place in the curricula of the Colleges and Universities. The Bureau of Agricultural Economics of the United States Department of Agriculture had set up a research department which fostered and assisted extensive rural surveys. The Purnell Act of Congress in 1925 authorised the agricultural experiment stations to use funds for economic and rural research, and various private agencies, notably the Institute of Social and Religious Research, were working in the same field. These institutions, he suggested, should serve as models for similar work in this country.

He said he had seen a certain amount of the work that was being done in India and he could assure them it was of tremendous importance. Valuable work had been done in the Punjab and in parts of Bengal; private individuals and organisations were also engaged in similar work, notably

the Servants of India Society and the Gokhale Institute of Politics and Economics. Where the services of the Department of Agriculture were required in Ceylon was to educate and guide workers in the outstations. Those who engaged in this work would have to come down to the standard of the villager and move freely among them and with them; only then would they be able to achieve anything. The Banking Commission, he pointed out had recommended a Central Statistical Bureau, and the need for it could not be too strongly emphasised. What, for example, did they know of the economics of paddy ? Many policies were based on ill-informed facts. It was just over a hundred years he said, since the matter was taken up in England. The Manchester Statistical Society was founded in 1833: it was perhaps the second oldest in the world and was the forerunner of many Societies in England, the next being the London Society, now known as the Royal Statistical Society, followed by the Statistical Office of the Board of Trade. It was to these, he said, that England owed her system of public elementary education. In conclusion, he stressed the value of collecting statistical information for nation-building purposes. Agriculture, health and education should each have its own bureau of research, all co-ordinated under one Central Authority.

Mr. Montague Jayawickreme in seconding the resolution stated that the Committee of the Empire Marketing Board had recommended that agricultural economics should be regarded as an essential part of agricultural research.

DISCUSSION

Mr. E. E. Megget said that Mr. Wilmot Perera had put before the meeting two outstanding problems; the research and statistical side, and finally the educational side. It appeared to him that the efforts that were being made since the reconstruction of the Board were beset by two difficulties; on the one hand they could not do anything because they had no money, and on the other because people were not interested. In other words they had to carry on concurrent with any activities, an educational programme the financial needs of which were not forthcoming. In his district they required one or two experimental stations to show the villagers what could be done but they had dropped the idea because they had not been able to find the money. He emphasised the vital necessity for an educational programme to promulgate what was being done on the statistical side and as regards agriculture.

The Chairman said he assumed that Mr. Wilmot Perera, both in his own motion and in that of the Kalutara District Agricultural Committee which he had proposed, envisaged that the first step in the collection of statistics should be the employment of a statistical officer. As most of them were aware, the compilation of statistics in this Island, apart from the plantation crops, had been somewhat lacking in the past. The Registrar-General was at present responsible for the collection of statistics and it was to him that they had to look for such statistics as were required. He considered that attention should first be focussed on that aspect of the matter before a statistical officer were employed; whether any recommendation should be made on the subject and, if so, to what department such an

officer would be best attached. The statistical officer would no doubt be conversant with agriculture, but other statistics bearing on agriculture, such as irrigation and forests would have to be collected. He thought that attention should be given first to the necessity or otherwise for the creation by Government of a statistical department to deal with agricultural crops, especially those not at present included. The statistics of plantation crops in Ceylon, compared with other countries, were extremely accurate as far as his experience went.

Mr. L. W. A. de Soysa said that if such an officer were attached to each provincial Kachcheri under the Government Agents he would be able to work with other officers which would facilitate the collection of information from the rural districts.

The Chairman said that the Indian statistics, which were rather elaborate, were compiled by the revenue officers. Every crop of importance in an Indian province, such as cotton, wheat or rice, was reported on by the revenue officers at least three times in the course of its growth. He had had occasion to check very carefully the estimates of the cotton crop in one of the provinces in India, and, in spite of a lot of criticism, it was very remarkable how close such forecasts were. In connection with Indian crops there was a fairly easy method of checking the major products, which were not so much plantation as village crops. Cotton for example, could be checked by its movement through the ports together with the addition of the quantities used by the local mills. The great problem was that of domestic needs, which could only be estimated by guesswork. The great importance and value of statistics was shown by the fact that at least half a dozen of the firms dealing in cotton used to compile their own statistics and they were always anxious to know the Government figures. Unfortunately so far as peasant agriculture was concerned, Ceylon did not produce many crops that were exported. The compilation of statistics would have another very important function; it would enable them to supply a great deal of information about which they were at present in the dark, not only as regards the cost of production but also as regards its increase. Even the Agricultural Department could never do more than make a shrewd guess of the quantity of paddy grown each year or the increase in the number of bushels of paddy. They had no definite information whether they were going forward, even with such a large crop as paddy. They would welcome statistics if they could be obtained in any way. He considered the importance of collecting statistics could not be doubted, and, as Mr. Wilmot Perera had said, the Banking Commission had commented on their absence. This Board, he thought, should first of all decide as regards the desirability of compiling statistics of agricultural crops such as are not already compiled, and secondly how it should be done.

Mr. G. Bruce Foote said that there was need for a statistical branch in the Department of Agriculture and that he wished to accord his support to this motion.

Dr. R. V. Norris said he thought this matter was a much wider one than that of merely assessing the total yields of different crops. Such information would be useful, but what was far more important was the actual

economics of these crops; for example what it cost to produce the various crops in different districts, and information as to which crops were most suited to certain particular areas. He thought that if statistics were only limited to the mere collection of details of yield they would obtain very little information; it should go very much deeper than that. He agreed with Mr. Bruce Foote that there would be ample scope for a statistical branch in the Department to collect information on crops.

Mr. E. E. Megget said that any statistics should show what use is made of the available area of land as he considered there was a lot of idle land.

The Chairman said he would like to hear further opinions, before he put the subject to the Board, as to whether a statistics officer should be appointed and whether the Agricultural Department was the one to which he should be attached.

Mr. Huntley Wilkinson said that it was a very big question which should be thought over a lot more. He suggested that it be discussed further and considered at a later meeting.

Mr. Bruce Foote said he thought that the members would like to study the subject and have time to consider it. He suggested that Mr. Wilmot Perera's paper be circulated so that they could study it.

Mr. Huntley Wilkinson agreed to this.

Mr. Wilmot Perera, in reply to a query by the Chairman as to whether he was agreeable to this and to allowing the matter to stand over, said he agreed and offered to supply some copies of his booklet for circulation at the same time as the minutes. He did not agree with headmen collecting the statistics and considered it hopeless to expect them to do it; he did not propose crop forecasting but what he had in mind were regional surveys and the collection of statistics relating to agricultural problems. His suggestion was that agricultural statistics should be collected by an agricultural officer and that officers should work similarly in the Departments of Education and Health.

The Chairman said he thought it could not be done in his or other departments by the present staff; a statistician had to be a mathematician rather than an agriculturist.

Mr. E. E. Megget suggested that the matter also be referred to the District Agricultural Committees for them to consider.

Mr. Bruce Foote suggested that this should be done before the next meeting in May.

It was unanimously decided that the suggestion of Mr. Huntley Wilkinson be adopted and that further consideration of the two motions be deferred till the next meeting at which a report be submitted indicating the views of the District Agricultural Committees.

MEANS OF OBTAINING A BETTER PRICE FOR LOCALLY GROWN PADDY

The Chairman called upon Mudaliyar N. Wickremaratne to speak on the resolution that he wished to propose with regard to locally grown paddy.

Mudaliyar Wickremaratne said that no one would gainsay the fact that food and clothing were the most essential necessaries of the life of a nation.

He considered that both these requirements could be met in Ceylon by local production, and that it was a reflection on them that they had to depend on foreign countries for these needs. He wished to discuss the necessity for growing their own supply of paddy, which was the staple food of the people, and for finding means to make paddy cultivation a remunerative industry. The paddy question, he indicated, had been discussed on many occasions and he himself had been connected with it for nearly thirty years. No solution had been arrived at and Ceylon still imported from India too large a proportion of her requirements. Those who remembered the threatened food-shortage in 1919-1920, would realise the seriousness of a similar situation which they might have to face in the near future, particularly when their money-producing industries were suffering from depression. During the 1919-1920 rice crisis even the well-to-do were not able to procure rice. Fortunately the North-Central, North-Western, and Eastern Provinces which had some surplus paddy at the time, came to the rescue to some extent. Today, however, even these Provinces were at the door of famine as the failure of one crop had brought about a serious shortage of seed-paddy and foodstuffs, clearly indicating that the paddy situation was now worse than it previously was.

Referring then to records contained in ancient chronicles of great repute, the *Mahawansa*, the *Rajawaliya* and the *Pujewaliya*, Mudaliyar Wickremaratne quoted instances of how the ancient rulers of Ceylon had encouraged the production of supplies of rice which were even greater than the requirements of the people. This, he said, was evidence that sufficient rice for their consumption could be grown in Ceylon if it were set about in the right way.

As recently as the 16th, 17th and 18th centuries, when the seaboards of the Island were in the hands of the foreigner, the country had sufficient food to maintain its own people, and during the wars with the Portuguese, the Dutch and the English it was the custom of the country to supply the requirements of the King's Army when they passed through a village. With the advent of these nations an import trade of some produce or other began, to the gradual detriment of local rice production. In the beginning it was the surplus of cinnamon and arecanuts that was exported, but after the British occupation attention was given to crops in use in European countries and the indigenous crops, such as paddy, were neglected. The growing of cinnamon, coffee, citronella, cinchona, cacao, tea, rubber and coconuts was taken up one after the other and all the energy of the country was employed to this end. But the end had now been reached and he could not foresee that any other crop would arise in which the production for export could succeed any of these previous crops. This being the case he considered it was necessary that they should now turn their attention to a crop which was in great demand locally. Paddy would not only supply an essential need, but would also enable them to retain in the country a large sum of money which they could ill-afford to allow to go out of the Island.

Some efforts in this direction had been made by some of the more sympathetic administrators. Sir Henry Ward, he said, was the first Governor who gave his attention to the resuscitation of paddy cultivation by his devoted interest in the restoration of ancient tanks. Later, Sir

Henry Blake established the Ceylon Agricultural Society for the advancement of village agriculture, primarily the cultivation of paddy. The Department of Agriculture then came into existence as a result of the activities of the above Society, and its first Director in his new scheme of organisation instituted a branch to give attention to the important question of paddy cultivation and allied products, entrusting this to that experienced officer Mr. C. Drieberg. Unfortunately he left the Island before he could do anything much with his wonderful enthusiasm. He was succeeded by that able and most energetic Director, Mr. F. A. Stockdale, as a result of whose interest in paddy cultivation and village agriculture Sir Hugh Clifford expounded his new land policy at a meeting of the former Board of Agriculture. As an outcome of this, he believed, the energetic and resourceful Minister of Agriculture and Lands was able to launch his land policy and Land Bill, an action that would be a landmark in the history of Ceylon. A further step taken by Mr. Stockdale had been the appointment of a number of paddy Sub-Committees under the Board of Agriculture to make investigations into the question of paddy cultivation. These Committees made very useful reports but in the meantime Mr. Stockdale left the Island. His successors placed these reports before the Board of Agriculture which made a series of recommendations to Government which appointed a Commission. This Commission never made a report so that the efforts made in this matter ceased to produce any conclusive results. The reports of the Sub-Committees contained numerous valuable suggestions and it was a pity they were not given the more careful attention that they should have received.

Continuing, Mudaliyar Wickremaratne indicated that the paddy industry today had sunk to the lowest level as regards its market value, so much so that no agriculturist except the poor goiya looked at it with any interest or sympathy. The question was often asked, whether it paid, but if it did not, he said, it must be made to pay. He was of the opinion that paddy cultivation was a necessity and not a matter of rupees and cents. It was time that the planter and the Government joined the goiya in making a supreme effort to grow a sufficient rice supply to meet their requirements. The planter did not take to paddy cultivation as it did not give a return for his outlay; the goiya could not produce a surplus as it did not give him a living wage. To overcome this extraordinary situation, he said, they had to look to the Government, as it was the Government alone who could help them in their dire need. A benevolent and sympathetic Government should look ahead and avoid calamities and his suggestion was that it should take steps to put forward a special effort to encourage paddy cultivation. While everything possible was being done today as regards restoring irrigation works, improving methods of cultivation, and the improvement of seed selection, Government should subsidise paddy cultivation for a number of years, at least until they could grow a substantial part of their own requirements and take measures against foreign competition. What he ventured to suggest was that a minimum uniform price per bushel be fixed and so control the price of rice in the Island as a whole. The necessary expenditure could be met from the duties now levied on imported rice or out of the general revenue.

The control of rice might keep the price at a level which would not allow the estates, which were large buyers of rice, to suffer. In support of his suggestion he quoted from evidence given by the Earl of Crawford and Mr. F. D. Ackland, at the time President and Parliamentary Secretary respectively to the British Board of Agriculture and Fisheries, who were unanimous that in order to obtain a large increase in the production of cereals, some form of security was essential which should take the form of a guarantee of a minimum uniform price.

In concluding, he requested the Director of Agriculture to consider whether the Divisional Agricultural Officers and their Agricultural Instructors could be employed to take a survey of every cultivable paddy land in their respective areas and to systematically bring such lands under cultivation; also to take steps to establish Central Depôts for storing surplus paddy in every area so as to protect the country from seasonal slumps.

Mudaliyar Wickremeratne then proposed the following resolution with the suggestion that it be transmitted to the Minister for Agriculture and Lands:

> "That in order to increase the production of paddy for the national security of the people of this Island and in order to induce the general agricultural communities to take to paddy cultivation, a guaranteed uniform minimum price for paddy should be fixed by Government."

The Chairman in reply to a query by Mr. Rolf Smerdon, agreed that the suggestion put forward by Mudaliyar Wickremaratne appeared to be covered by the motion of Mr. Subramaniam that was now before the State Council.

Mr. C. Arulambalam, in seconding the resolution, stated that during the 1919-1920 period when the price of paddy went up to six rupees, large tracts of jungle land were taken up for paddy cultivation in the Punakari district, but when the price of paddy fell the land was abandoned. He considered that a minimum price was the only way of dealing with the situation.

Mr. Wace de Niese observed that had the ancients mentioned by Mudaliyar Wickremaratne known of tea, rubber and coconuts they would have abandoned paddy cultivation for the better dividends yielded by those crops. The Ministry were doing all they could to help the industry but paddy cultivation had never paid and that was the reason why the Sinhalese worked on tea and rubber estates. A minimum price, he said, would have to be more than the cultivator got today. He thought that as it was the Ministry was spending far too much. Before the country could produce all its requirements of rice, hospitals should be opened and the malaria question tackled.

Mudaliyar Wickremaratne said that if muttusamba rice could be sold at five rupees per bushel he did not see why a better kind of village grown rice should be supplied at two rupees per bushel. That was why he considered that Government should fix a minimum price and control the supply of rice. There was a large surplus and he did not see why the

villager should not be helped; with lower prices for tea, rubber and coconuts the villager had not the same opportunity for employment as in the past.

During further discussion, in which Mr. Rolf Smerdon outlined what the effect would be of the motion before the State Council by Mr. Subramaniam, Mr. Wilmot Perera agreed with an observation by Mr. Megget that it was too large a question for the Central Board to pass a resolution on. The question of tariffs and control, said Mr. Wilmot Perera, were not matters on which they were competent to form an opinion. So far as he could see the only possibility would be to nationalise all paddy land.

After further discussion Mr. James Forbes (Jnr.) proposed and Mr. E. E. Megget seconded:—

"That the subject be deferred till a later date."

The Chairman put this proposal to the meeting and it was carried by a large majority. This, he said, ruled out the original proposal and the subject might be brought up at a later date.

The meeting terminated at 5-23 p.m., the Chairman thanking the members for their attendance.

W. C. LESTER-SMITH,
Secretary,
Central Board of Agriculture.

DEPARTMENTAL NOTES

FIELD DAY AT LABUDUWA FARM, GALLE

G. HARBORD. DIP. AGRIC. (WYE)

DIVISIONAL AGRICULTURAL OFFICER, SOUTHERN, GALLE

A 'field day' was organised at the Central Agricultural Station, Labuduwa, Galle on Monday, January 21st, 1935, which drew large numbers of interested agriculturists to the Farm throughout the day.

In addition to large contingents of the peasantry, the visitors included representatives of the Divisional Agricultural Associations of the six Pattus of the Galle District, and many Chairmen and members of Village Committees besides members of Co-operative Societies.

Quite a number of minor headmen from all Pattus, and the Chief Headmen of Talpe Pattu also attended.

PADDY

The harvesting of the Maha crop of Suduheenati pure-line paddy was being carried out—and visitors were thus able to watch the performance of various labour-saving devices.

(a) A Japanese hand-threshing machine. The general impression was that this ingenious machine could not compare in efficiency and output with the local method of threshing—the man-treading process.

(b) A Winnowing Machine.—The visitors were much impressed with the speed in operation and the superior sample of paddy turned out by this machine which has an output of 100 bushels per day.

It was explained that a similar machine was on ioan at Babarenda South (Wellaboda Pattu, Matara) and was being successfully worked on a co-operative basis.

(c) A Malay Rice hulling machine. Great interest was shown in this machine.

The general opinion was that, both in performance and output, it showed great superiority over the local pounding methods, and many visitors expressed a desire to procure machines of this type.

(d) Light Mould-board ploughs. (Victory, Meston, Arumugan, Molegode) and also Burmese harrow. Ploughing demonstrations were carried out showing the superiority of the Victory plough for high-land weedy fields; the Arumugam plough for general work on mud lands and also the general utility of the Burmese harrow—provided capable draught cattle are available.

(e) Numerous field-plots of Balamawi selections. It was explained that the final selection was now being carried out of a Pure-line for use in the Weligama tracts of Matara District.

DAIRY

The herd of 26 animals of the Montgomery breed (the best Indian milking breed) was inspected, and the visitors saw for themselves the feeding methods which were practised—including the provision of regulated concentrates, green fodder, and ample free grazing.

They also gained an insight into the system adopted for the production of pure clean milk.

It was explained that bull calves were being raised for sale to local dairy owners for stud purposes.

COFFEE

Considerable interest was shown by many visitors in the plantation where four varieties of the Robusta type are being cultivated under Leucaena glauca, as the most suitable form of shade.

TEA

The two and four year-old plantations grown on the contour system of planting and provided with ample shade trees (grevillea, gliricidia and albizzia) were critically examined; favourable comment was made as regards the development of bushes resulting from the pruning system etc.

FRUIT SECTION

The plantation of Pineapple (Kew), Sapodilla (grafted), Mangosteen, Orange (Washington Navel), and miscellaneous fruit trees, was visited.

Methods of controlling plant pests and diseases by the use of spraying machines was demonstrated.

PLANT SUPPLY NURSERIES

The nurseries of coffee, fruit plants, kapok, tea and shade trees, established to provide planting material for issue to general agriculturists and peasant proprietors, were inspected.

FODDER GRASS PLOTS

The areas reserved for the production of green fodder for stall-feeding to the dairy herd, interested the visitors, the majority of whom were cattle owners. They were able to compare crops of Guinea grass, Napier grass and Mauritius grass being raised in soil conditions best suited for their growth.

The wonderful response of these crops to applications of farmyard manure was stressed.

COMPOST PITS

(Size of pit: 8 × 8 × 8 ft.) The pits were visited and the contents examined.

The value of conserving all forms of vegetable refuse for the manufacture of compost—a cheap, but beneficial, form of manure—was clearly demonstrated.

ANIMAL DISEASE RETURN FOR THE MONTH ENDED 28 FEBRUARY, 1935

Province, &c.	Disease	No. of Cases up to Date since Jan. 1st 1933	Fresh Cases	Recoveries	Deaths	Balance Ill	No. Shot
Western	Rinderpest	...	...	...	...	...	...
	Foot-and-mouth disease	43	...	43	...	...	...
	Anthrax	...	...	...	...	..	...
	Rabies (Dogs)	2	1	...	...	...	2
	Piroplasmosis	...	...	.	...	...	...
Colombo Municipality	Rinderpest	..	...	...	...	...	...
	Foot-and-mouth disease	2	...	2	...	...	...
	Anthrax	...	...	...	...	...	...
	Rabies (Dogs)	2	2	...	...	...	2
	Haemorrhagic Septicaemia	...	...	...	...	...	...
	Black Quarter	...	...	...	...	...	...
	Bovine Tuberculosis	...	...	...	...	...	
Cattle Quarantine Station	Rinderpest	.	...	...	...	..	...
	Foot-and-mouth disease	...	...	...	...	...	...
	Anthrax (Sheep & Goats)	28	17	...	28	...	...
Central	Rinderpest, Foot-and-mouth disease, Anthrax, Bovine Tuberculosis, Rabies (Dogs)	FREE					
Southern	Rinderpest, Foot-and-mouth disease, Anthrax, Rabies (Dogs)	FREE					
Northern	Rinderpest, Foot-and-mouth disease, Anthrax, Black Quarter, Rabies (Dogs)	FREE					
Eastern	Rinderpest	...	...	...	...	...	...
	Foot-and-mouth disease	40	28	40	...	...	...
	Anthrax	...	...	...	...	..	...
North-Western	Rinderpest	.	..	...	...	...	...
	Foot-and-mouth disease	64	64	39	4	21	...
	Anthrax	...	..	...	...	...	...
	Rabies (Dogs)	3	3	...	1	...	2
	Piroplasmosis	...	...	...	...	..	...
North-Central	Rinderpest, Foot-and-mouth disease, Anthrax	FREE					
Uva	Rinderpest	...	...	...	...	...	...
	Foot-and-mouth disease	45	45	44	1	..	...
	Anthrax	...	...	...	...	...	...
	Bovine Tuberculosis	...	...	.	...	..	.
Sabaragamuwa	Rinderpest	...	...	...	...	...	...
	Foot-and-mouth disease	...	...	...	..	...	..
	Anthrax	...	...	...	...	...	...
	Piroplasmosis	...	...	..	...	...	...
	Haemorrhagic Septicaemia	5	5	2	3	...	..
	Rabies (Dogs)	1	1	...	...	...	1

G. V. S. O.
Colombo, 15th March, 1935.

M. CRAWFORD,
Government Veterinary Surgeon.

METEOROLOGICAL REPORT,

FEBRUARY, 1935

Station	Temperature				Humidity		Amount of Cloud	Rainfall		
	Mean Maximum	Difference from Average	Mean Minimum	Difference from Average	Day	Night (from Minimum)		Amount	No. of Rainy Days	Difference from Average
	°	°	°	°	%	%		Inches		Inches
Colombo	86·8	+ 0·1	72·1	+ 0·5	71	90	5·8	2·78	6	+ 0·59
Puttalam	89·1	+ 1·2	69·4	- 0·3	66	93	4·9	1·72	5	+ 0·43
Mannar	87·3	+ 0·5	72·9	- 0·6	68	88	4·8	0·94	3	- 0·35
Jaffna	85·4	- 0·1	72·6	+ 1·2	66	88	3·5	6·20	2	+ 4·95
Trincomalee	81·8	- 0·9	76·1	+ 0·5	74	79	5·6	1·30	4	- 0·86
Batticaloa	82·4	- 0·4	73·7	+ 0·3	76	90	7·0	2·28	8	- 1·25
Hambantota	85·0	- 0·9	72·2	- 0·3	70	90	4·6	0·92	7	- 0·49
Galle	84·9	- 0·5	73·5	+ 0·3	76	90	5·4	1·93	7	- 0·98
Ratnapura	91·1	- 0·6	70·1	- 0·9	68	95	4·9	2·02	8	- 2·59
A'pura	88·2	+ 1·9	66·7	- 2·8	66	95	6·6	0·64	4	- 0·94
Kurunegala	89·4	+ 0·1	68·3	- 1·1	60	95	4·6	1·01	5	- 0·80
Kandy	84·7	- 1·1	67·1	+ 0.3	57	85	4·2	3·38	7	+ 1·08
Badulla	77·8	- 1·0	63·1	+ 0·4	75	91	5·2	2·82	8	- 0·14
Diyatalawa	73·4	- 1·4	56·2	+ 0·4	66	88	5·6	0·88	6	- 1·45
Hakgala	69·8	+ 0·8	50·0	+ 0·2	71	84	3·8	1·93	8	- 1·47
N'Eliya	69·6	- 0·1	44·0	+ 0·4	59	85	6·5	1·35	7	- 0·69

In the northern half of Ceylon, February rainfall was generally below average, except along the north-west coast and in the Jaffna Peninsula. South of the line joining Puttalam and Batticaloa, excesses and deficits were irregularly distributed, and were usually small. Excesses up to 5 inches were reported from several stations in the north and north-west of the hills, and in the districts to the south and south-east of Puttalam. The south and east of the island, including the southern and eastern slopes of the hills, were generally in deficit.

February averages are small in most parts of the Island, and slight or moderate excess does not usually imply a heavy rainfall. No station reported a monthly total of 10 inches of rain, and only a few districts, chiefly in the south-western low-country adjoining the hills, and on the north-eastern hill slopes, reported over 5 inches for the month. In the northern half of the Island, and the eastern half of the Southern Province, the districts south of Kurunegala, and the Uva plateau, rainfall totals were generally under 2 inches, though very few stations reported no rain at all.

Four stations reported daily falls of 5 inches or over, the highest being 6·30 inches, at Eheliyagoda, on the 17th-18th.

For the first half of the month there was very little rain, the usual northerly gradients and north-easterly winds being experienced. On the 14th there was wide-spread light or moderate rain, while for the next two days the rainfall was comparatively light, and mainly in or near the hills. On the 17th and 18th there were many heavy falls of rain, chiefly in the south-west, as the result of local afternoon or evening thunderstorms. On the 19th the weather moderated, and for the next three days was dry. On the 23rd the weather seemed more unsettled, and there was light or moderate rain in the north and east. On the 24th the rain was wide-spread over the Island, but generally moderate, while the weather then cleared, and very little further rain was reported till the end of the month.

Mean temperatures and humidities, as a rule, showed no marked deviations from normal. Clouding was above average. The barometer was generally a little deficit, while wind strength was above normal at most stations. The direction of the wind was generally NE to NNE.

H. JAMESON,
Supdt., Observatory